FX-Control User Manual

PC-Software for FX100 Audio Analyzer

Doc version *2.8.2/e*
Refers to SW *v2.8.2*

NTi Audio AG is an ISO9000:2008 certified company

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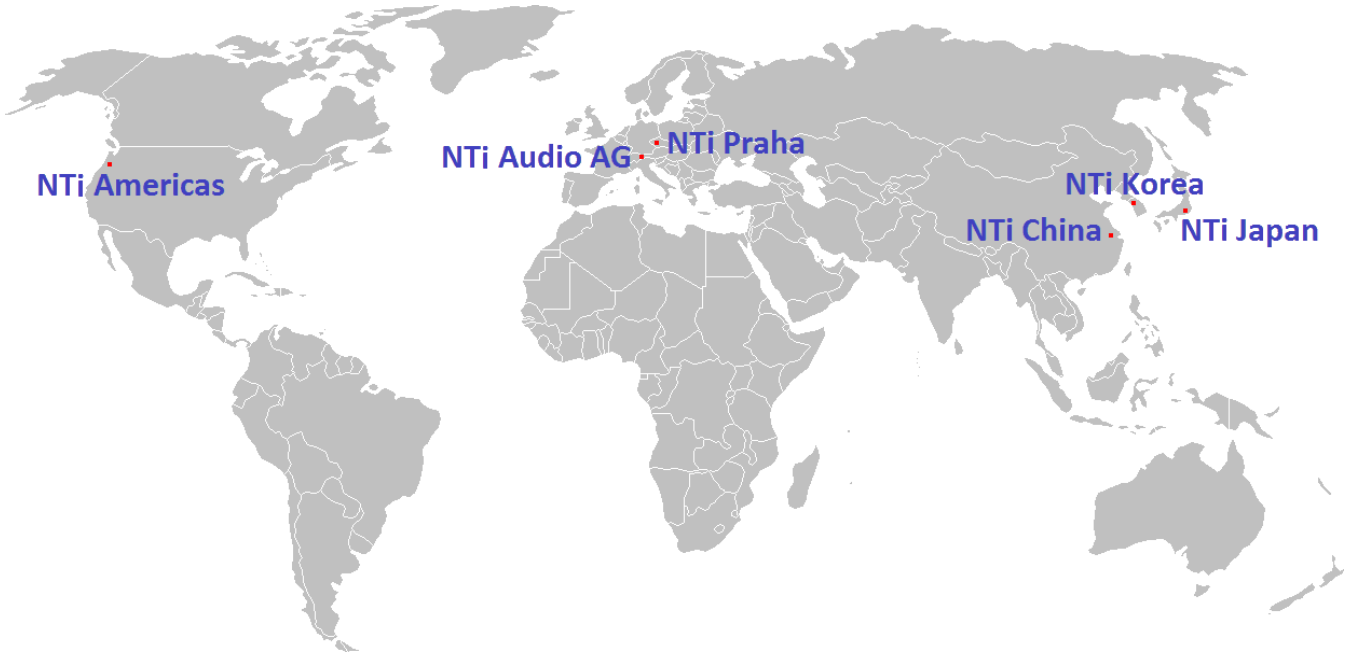
Part

1 Introduction

FX100 audio generator & analyzer together with the FX-Control software form a highly flexible, extremely fast and powerful test & measurement system that meets the requirements of a wide range of applications.

- R&D labs
- Mass production
- Service & repair centers

For dedicated support or calibration services, please contact you nearest NTi Audio partner.



© NTi Audio AG
Im alten Riet 102
9494 Schaan
Liechtenstein, Europe

Phone +423 239-6060
Fax +423 239-6089

www.nti-audio.com

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1.1 Safety instructions

- Operate the instrument only in appropriate environments and under the conditions specified by NTi Audio.
- Do not open, disassemble, modify or attempt to repair the instrument.
- Make sure that the instrument's nominal voltage setting matches the nominal voltage of the AC supply network before switching ON the instrument.
- Only operate the instrument with an intact power cable, where the protective earth connection is not broken.
- Pay special attention (especially to not isolated electrical contacts) if you are working with voltages > 50 V
- Install the instrument in a way that sufficient air ventilation is ensured. Do not close any slots or openings nor obstruct the instrument's internal ventilator.
- Do not place the instrument on or close to heat-generating devices such as radiators or fan heater.
- Make sure that the environmental temperature does not exceed the maximum temperature specified in the data sheet.
- Do not insert any objects into the openings in the housing or pour any liquids onto or into the housing.
- Keep in mind that this instrument has no brain – use your own!

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1.2 HW, SW installation

Hardware

- Carefully unpack the instrument and place it on a flat, stable surface.
- Connect the instrument to AC mains via the power cord.
- Link the CPU board to the controller PC via a standard USB cable.
- Switch the instrument ON.

PC-software

Controller-PC requirements

• CPU	Pentium 400 MHz, 96 MB RAM (*minimum*)
	Pentium 1 GHz, 256 MB RAM (*recommended*)
• Architecture	x86 or x64
• Operating system	Windows XP SP3 or higher (64 bit versions of Windows are supported)
• Windows installer	3.1 or higher
• Internet explorer	5.01 or higher
• Communication interface	USB (TCP/IP interface not yet supported)

Software installation procedure

1. Insert the CD
2. Double-click on the icon "Setup.exe"

Hint ***If the connected FX100 device is replaced by another unit, a hardware scan has to be executed to re-establish system operation.***

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1.3 License agreement

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Part II

2 Hardware

NOTE **NTi Audio recommends annual calibration of FX100. A message on the unit's LCD indicates expiration of this period.**

FX100 front panel

1	Display	The LCD provides basic information on the instrument status and test results
2	PASS / FAIL indicator	The **green** / **red** light bars directly indicate the PASSED or FAILED test result
3	Mains switch	Switches the instrument ON or OFF
4	Rotary encoder	i. Rotating the encoder • adjusts the volume of the monitor jack, or • moves the cursor through the menu, or • varies the selected menu entry, ii. Press the knob to select the highlighted menu entry.
5	USB interface	USB type A connector data transfer between memory stick and instrument • test parameters (stick → instrument) • result data (instrument → stick)
6	Headphone jack	Provides the input signal (unprocessed or filtered)

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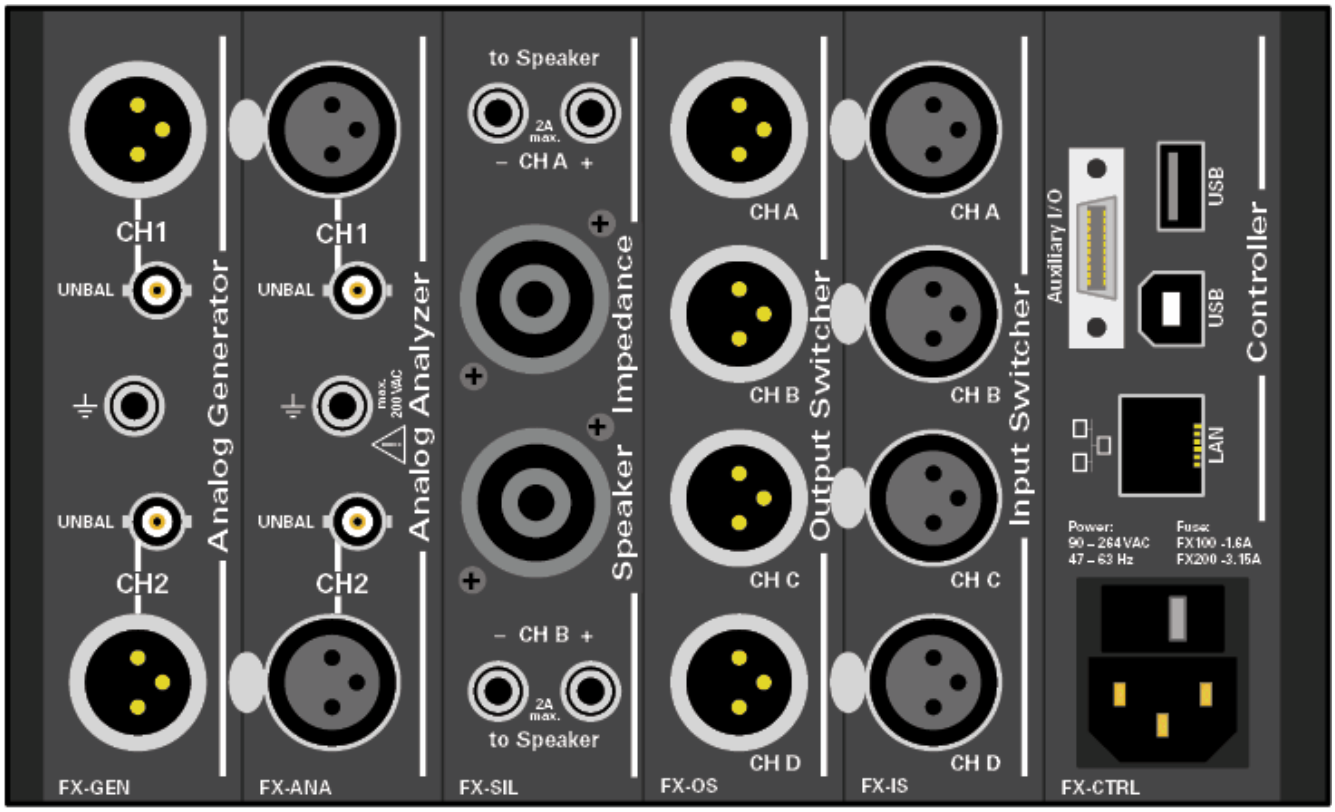
FX100 rear panel

The rear of the FX100 hosts the plug-in boards that can be configured according to your requirements.



Analog generator *Analog analyzer* *SIL* *Output switcher* *Input switcher* *Controller*

Standard configuration

- Controller board
- 2-channel analog generator (DAC)
- 2-channel analog analyzer (ADC)

Optional plug-in boards

- additional 2-channel analog generator + analyzer (=> 4-chn in total)
- 4-channel output switcher (1-in-4 or 2-in-2)
- 4-channel input switcher (4-in-1 or 2-in-2)
- 2-channel speaker impedance low (max. 2 A) measuring board
- 2-channel speaker impedance high (max. 10 A) measuring board
- Speaker impedance power board with built-in amplifier and current sensor
- Low-pass filter board for D-class amplifier testing
- AES3 digital audio interface board

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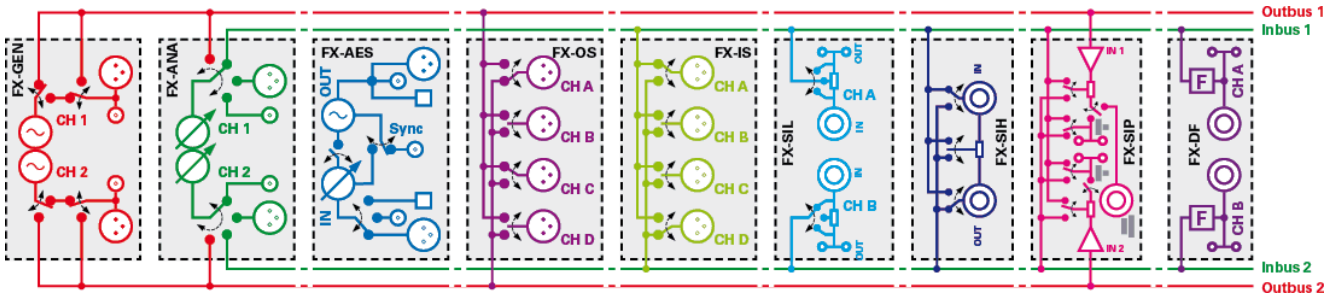
FX100 audio boards & buses



FX-GEN analog generator

Output channels 1, 2 can be linked individually to the

- XLR + BNC connectors
- Outbus

FX-ANA analog analyzer

Input channels 1,2 can be linked individually to the corresponding

- XLR, BNC connector
- Inbus or OutBus (→ readback measurement)

FX-AES digital generator & analyzer

Output is permanently linked to the corresponding XLR, BNC and TOSLINK connectors

Input can be linked individually to the XLR, BNC or optical TOSLINK connector

FX-OS analog output switcher

Each connector can be linked individually to the Outbus 1 or 2 (only one link per Outbus at a time)

FX-IS analog input switcher

Each connector can be linked individually to the Inbus 1 or 2 (only one link per Inbus at a time)

FX-SIL analog speaker impedance low (max. 2 A)

The Speakon™ input connector, shunt resistor or Banana output connector can be linked to Inbus 1, 2

FX-SIH analog speaker impedance high (max. 10 A)

The Speakon™ input connector, current sensor or Speakon™ output connector can be linked to Inbus 1, 2

FX-SIP analog speaker impedance power

The integrated power amplifier and current sensor can be linked to the Banana and Speakon™ output connectors

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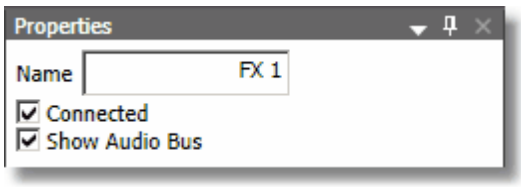
FX-DF low-pass filter for D-class amplifier testing

The Speakon™ input connectors can be linked to Inbus 1, 2

NOTE **Aside from the standard analog generator & analyzer boards, FX100 can host a maximum of three plug-in options.**

FX100 mainframe properties

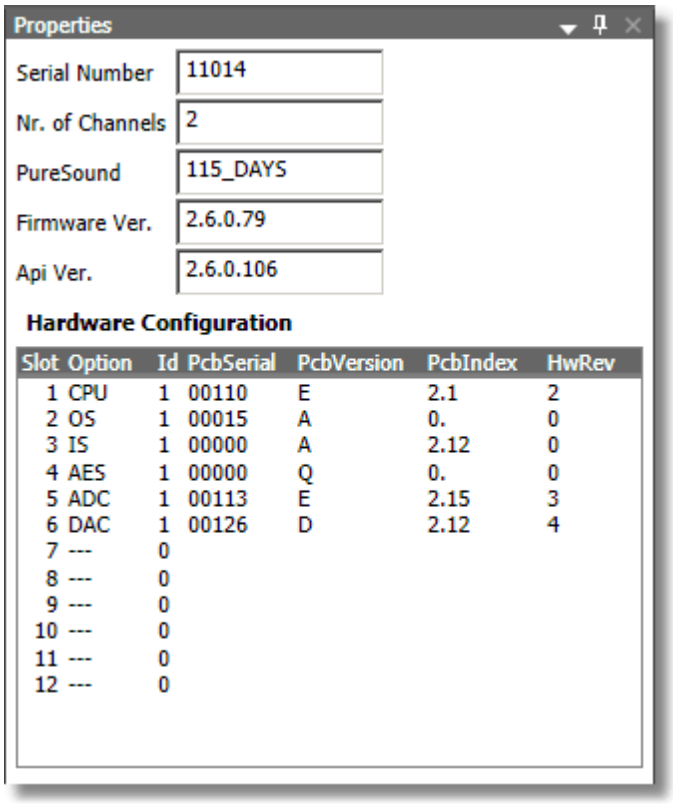
Hardware & Wiring properties



The FX100 properties that are displayed in the Hardware & Wiring view

- Name → the name of the connected FX100 can be customized
- Connected → allows to disconnect FX100 from the controller-PC; as soon as the instrument is re-connected, FX-Control is synchronized to its current status
- Show Audio Bus → displays or hides the Outbus, Inbus and related links in the Hardware & Wiring view

Worksheets


Properties
Serial Number 11014
Nr. of Channels 2
PureSound 115_DAYS
Firmware Ver. 2.6.0.79
Api Ver. 2.6.0.106
Hardware Configuration
Slot Option Id PcbSerial PcbVersion PcbIndex HwRev
1 CPU 1 00110 E 2.1 2
2 OS 1 00015 A 0. 0
3 IS 1 00000 A 2.12 0
4 AES 1 00000 Q 0. 0
5 ADC 1 00113 E 2.15 3
6 DAC 1 00126 D 2.12 4
7 --- 0
8 --- 0
9 --- 0
10 --- 0
11 --- 0
12 --- 0

The FX100 properties that are displayed in the Worksheets

- Serial Number → unique ID of the connected FX100 Device
- No. of Channels → number of installed generator & analyzer channels (2 or 4)
- PureSound → status of installed software options
- Firmware Ver. → version of the installed firmware
- Api Ver. → version of the API (Application Programming Interface) command set
- Hardware Configuration → installed boards with
  - Slot number
  - Name
  - ID
  - PCB serial number
  - PCB version
  - PCB index
  - Hardware revision

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2.1 Display & rotary encoder

The LCD & rotary encoder can be used for a number of features such as PASS/FAIL indication, headphone volume control or sequencer operation.

To access these features, move the cursor to the corresponding menu entry by turning the rotary encoder and pressing it for confirmation.

NOTE NTi Audio recommends annual calibration of FX100. A message on the unit's LCD indicates expiration of this period.

Test

Result

The key purpose of the LCD is to visually indicate the test result, which is further emphasized by two light bars on the left & right sides of the display. Suppose, for example, that the operator has defined tolerance limits for the active measurements. Then the light bars will glow either **green** or **red**, depending whether the last test PASSED or FAILED any of the given limits.

Messages

-----	idle state
Armed	analyzer waits for a measurement trigger
Measure	instrument is executing a measurement
Passed	measurement results meet the acceptance criteria (**green** light bar)
Failed	measurement results exceed the tolerance limits (**red** light bar)
Cal Req	FX100 needs to be calibrated (contact NTi Audio service station)

Alarms

OUTP1 OVLD	overload of output channel 1
OUTP2 OVLD	overload of output channel 2

Operating mode

This indicator shows the measuring mode in which the instrument is operating

Meter	Meter mode
StepSweep	StepSweep mode
GlideSweep	GlideSweep mode
Seq#	the active Sequence
TEST#:	the sequence that is currently executed

Furthermore, it indicates the current status of the corresponding mode, i.e.

⏸	idle
▶	running
⏭	waiting for trigger
⚙	sequencer configuration

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Remote control status

Shows the IEEE 488.1-1987 remote control status

LOC	Local
REM	Remote
LWL	Local with lockout
RWL	Remote with lockout

Err

System error queue

##.##	error number
Clear Queue	clears the error queue

Status of the ¼" headphone jack, which is used to monitor the incoming signal of the selected input channel

monitoring mode (Monitor or PureSound)

t#	input channel number
xx%	volume control

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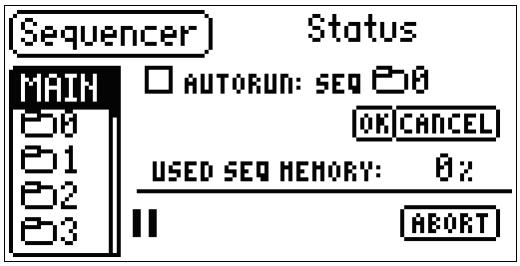
Sequencer

NOTE Please refer also to chapter "Sequences" for further details.

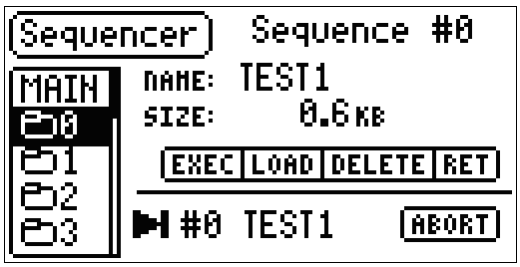
Main



The main sequencer status comprises the following elements

Autorun: Seq #	disabled ⇒ no sequence is active | enabled ⇒ FX100 automatically loads the selected sequence after start-up
OK | Cancel	confirm | cancel the current settings
Used Seq Memory: x%	memory space that is occupied by the stored sequences
Sequencer status	
▮▮	sequence stopped
▶▮ **# TEST**	sequence running
Abort	aborts the currently running sequence

Sequences



LCD content if a specific sequence has been selected

Sequence #	disabled ⇒ no sequence is active
Name	name of the currently active sequence (e.g. "Test1")
Size	memory space of the active sequence
Exec	start execution of the active sequence
Load	download a new sequence from the root directory of a connected USB stick
Delete	delete the selected sequence
Ret	return to sequencer list items
Sequencer status	
▮▮	sequence stopped
▶▮ **# TEST**	sequence running
Abort	aborts the currently running sequence

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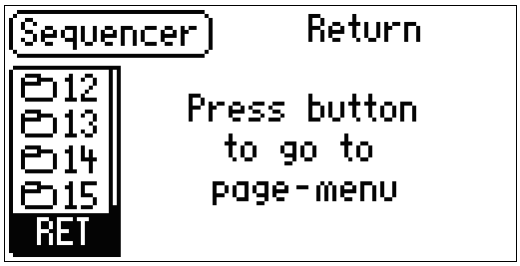
Ret



Return to main menu

Menu "System"

Menu entry	*Display*	*Supported actions*
?CAL	Date of the latest FX100 calibration, and the due date for the next calibration.	-
?SNR	Serial number of the FX100.	-
=VER	Actual version of the firmware, and of the OS/BSP image / boot-loader.	Start firmware update
?LIC	List of installed licenses and their expiration dates.	-
?HW	List of slots and installed boards with the respective versions.	-
=TIME	Date & time of the on-board real-time clock.	Adjust date & time
=IP	IP address of the FX100.	Adjust IP settings
=DNS	DNS of the FX100.	Adjust DNS
=TST	-	-
=AUX	Shows the input, output pin status of the auxiliary I/O interface	Set or clear output pins
RET	-	Return to main menu

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2.2 Headphone jack

The ¼" headphone jack on the front panel is used to listen to the input signal in two modes,

- Monitor - the input signal after the filter stage (e.g. A-weighting, lowpass etc.)
- PureSound - the input signal after the PureSound bandpass-filter

Channel selection and volume control are accessible in two ways, via the

- Toolbox → Advanced→ General → Headphone,
- display & rotary encoder.

2.3 USB-A ports

The USB-A ports on the FX100 front panel and CPU-board support the following features.

- Transfer of user-defined sequence(s) from a PC to the instrument
- FX100 firmware update

NOTE The FX100 operating system automatically labels the 1st USB-A that is connect as "USB HD". The 2nd USB-A that is connected is labeled "USB HD2".

2.4 USB-B port

The USB-B port on the CPU-board is the standard link to the controller PC.

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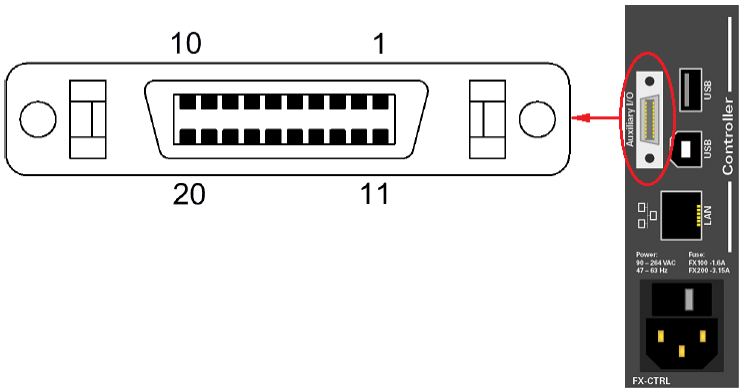
2.5 Auxiliary I/O interface

FX100 features a built-in auxiliary I/O interface that allows you to initiate measurements by an external trigger impulse, or provide feedback on the measurement status & outcome.

Pin assignment

Pin 1...8: Inputs (pin 1 = In 1 etc.)

Pin 9, 10: GND



Pin 11, 12: GND

Pin 13...20: Outputs (pin 13 = Out 1 etc.)

Electrical specifications

Input level range	max. –0,5 ... 5,5 V VIH = 2 V VIL = 0.8 V
Input impedance	10 kΩ
Output level range	3.3 V TTL VOHmin = 2.4 V (@ IOH = 3 mA) VOLmax = 0.4 V (@ IOH = –3 mA)
Output impedance	typ. 50 Ω; min. 43 Ω / max. 80 Ω

Cable connection

You may link the auxiliary I/O interface to an external device (e.g. PLC) by using a cable with a Mini D Ribbon (MDR) connector.

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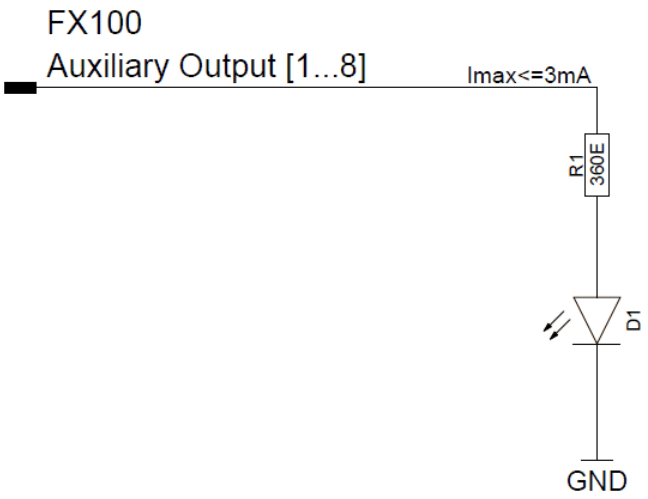
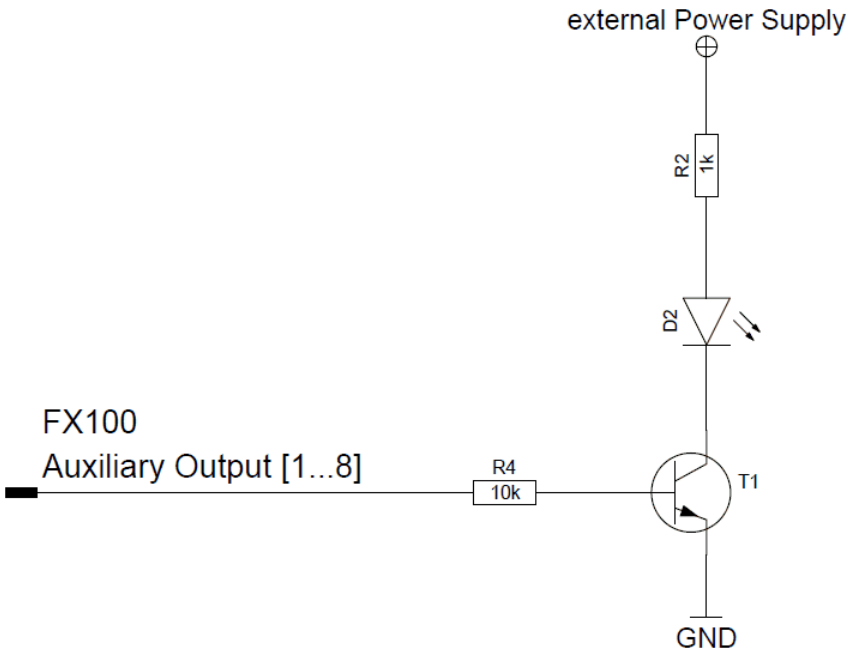
Auxiliary output wiring examples

Output interface circuit for LED < 3mA



Output interface circuit for LED > 3mA



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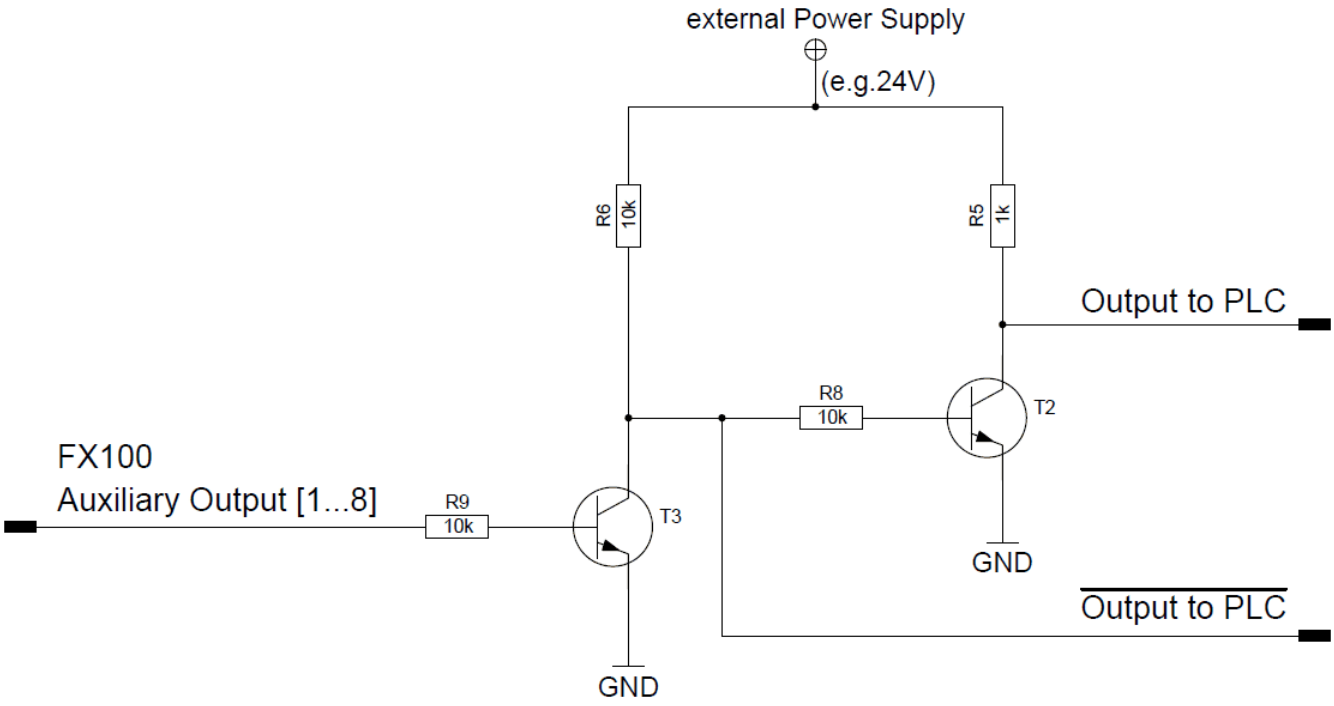
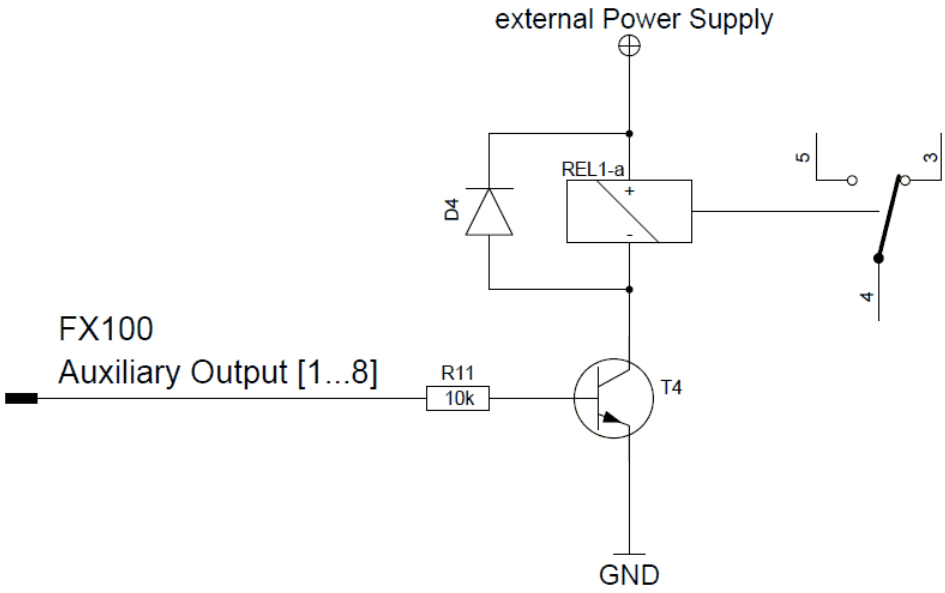
Output interface circuit for PLC



Output interface circuit for relay controls



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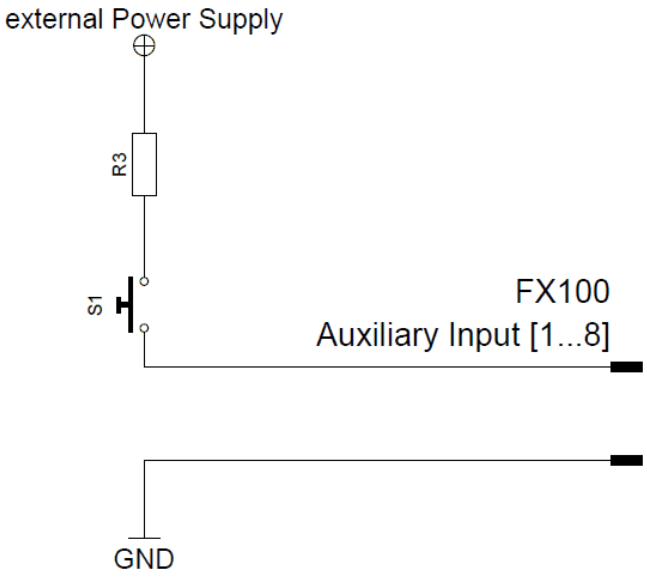
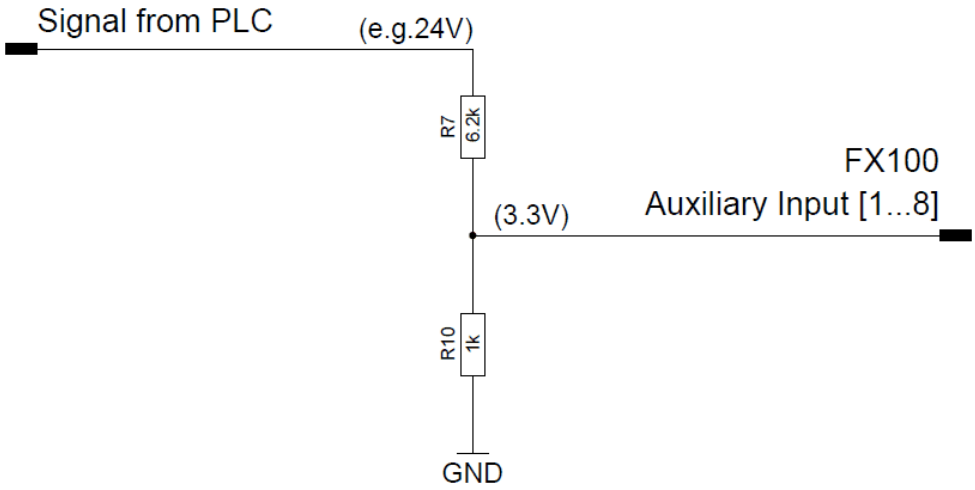
Auxiliary input wiring examples

Input interface circuit for push button



Input interface circuit for PLC



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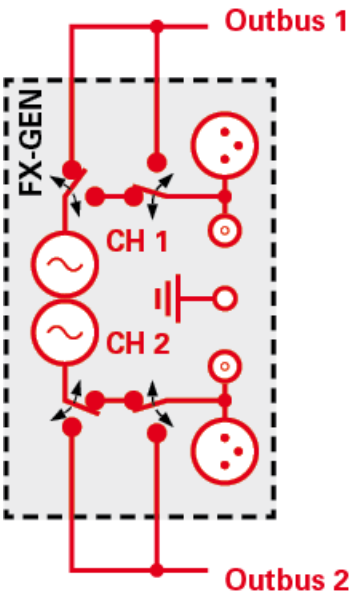
2.6 FX-GEN board

FX-GEN is a 2-channel high-precision analog audio generator

- The two generator channels can be parameterized independently (e.g. level, frequency, outstate, internal link)
- In case of StepSweep or GlideSweep measurements, both channels always start simultaneously
- FX-GEN must always be installed together with an FX-ANA board

NOTE The XLR + BNC connectors of FX-GEN
- **are permanently linked to each other**
- **can be linked either to the generator or the Inbus**

FX-GEN internal schematic



The generator channels 1, 2 can be linked to

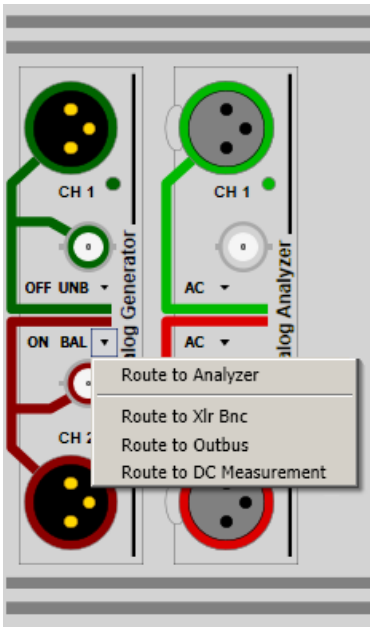
- XLR+BNC connectors 1, 2 respectively
- Outbus 1, 2 respectively
- DC Measurement

Furthermore, it is possible to link the XLR + BNC connectors 1, 2 via the Outbus to the analyzer inputs 1, 2 respectively.

Thus, it is possible to measure the bias of the input of a connected device (→ readback measurement).

To edit the internal wiring of the FX-GEN board, switch to the Hardware & Wiring view,

- click on the symbol of a generator channel and select the required status, or
- amend the corresponding settings via the properties (*see below*)



Furthermore, you may amend the following generator properties.

- ON / OFF → output connector active or muted
- BAL / UNB → balanced or unbalanced operation

Hint The Banana plug is permanently connected to GND (chassis)

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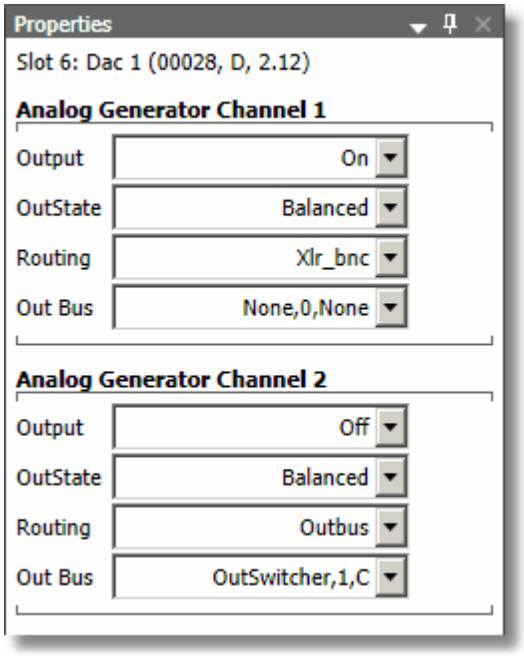
FX-GEN properties



The FX-GEN board has the following properties

- Slot number: DAC number (PCB serial number, PCB version, PCB index)
- Output → On or Off (muted)
- OutState → Balanced or Unbalanced
- Routing → internal link of the FX-GEN board (see above), i.e.
  - XLR+BNC, or
  - Outbus, or
  - DCmeasurement (the generator gets disconnected, whereas the built-in DC current source of the analyzer is activated)
- Out Bus → internal link of the Outbus, whereby "Module,No,Chn" stands for
  - Module → the plug-in module to which the Outbus is linked
  - No → number of the plug-in module (e.g. "2" = the 2nd of two installed FX-OS)
  - Chn → the module channel to which the Outbus is linked

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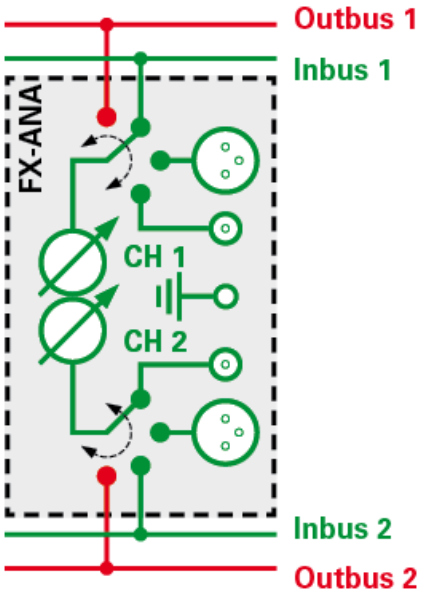
2.7 FX-ANA board

FX-ANA is a 2-channel high-precision analog audio analyzer

- In Meter, StepSweep or GlideSweep mode, the analyzer acquires all supported measurement functions, regardless of the queried results
- The bias of the two input channels can be adjusted individually
- In case of StepSweep or GlideSweep measurements, both channels always start simultaneously
- FX-ANA must always be installed together with an FX-GEN board

FX-ANA internal schematic



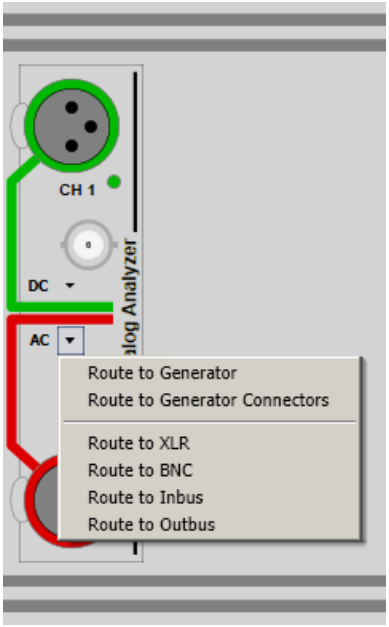
The analyzer channels 1, 2 can be linked to

- XLR connectors 1, 2 respectively
- BNC connectors 1, 2 respectively
- Inbus 1, 2 respectively
- Outbus 1, 2 respectively (readback measurements are possible with this configuration)

To edit the internal wiring of the FX-ANA board, switch to the Hardware & Wiring view,

- click on the symbol of an analyzer channel and select the required status, or
- amend the corresponding settings via the properties (*see below*)

Furthermore, you may edit the coupling of the input connectors by clickng on the AC / DC entry.



Hint ***If the DUT is floating (i.e. without any connection to ground) and unbalanced, its shield / ground must be connected to the Banana plug of the FX-ANA board, which is connected to GND (chassis)***

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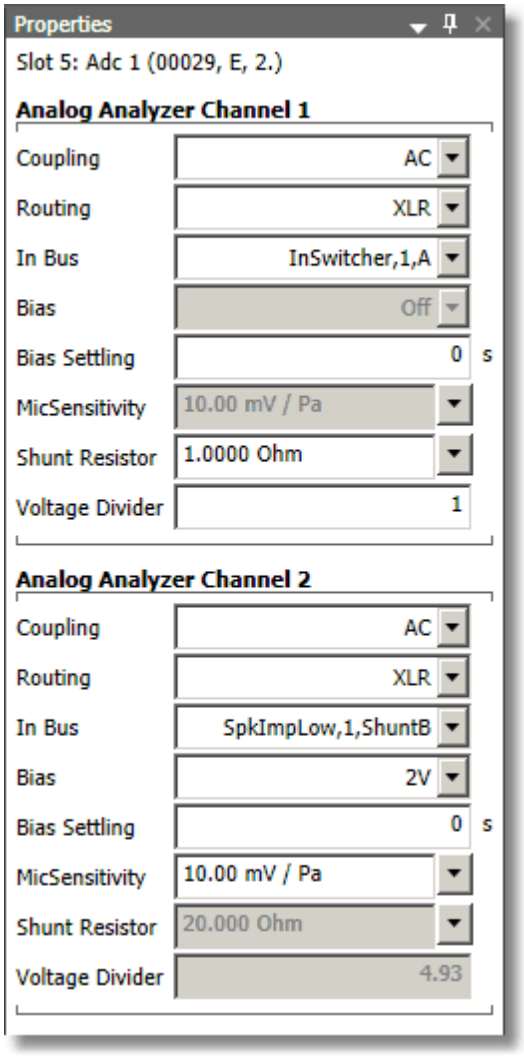
FX-ANA properties



The FX-ANA board has following properties

- Slot number: ADC number (PCB serial number, PCB version, PCB index)
- Coupling → AC or DC
- Routing → internal link of the FX-ANA board (see above), i.e.
  - XLR, or
  - BNC, or
  - Inbus, or
  - Outbus
- In Bus → internal link of the Inbus, whereby "Module,No,Chn" stands for
  - Module → the plug-in module to which the Inbus is linked
  - No → number of the plug-in module (e.g. "2" = the 2nd of two installed FX-IS)
  - Chn → the module channel to which the Inbus is linked
- Bias → optional offset voltage or current that is applied to the input connector(s)
  - 2V → Phantom power for 2 V microphones
  - 48V → Phantom power for 48 V microphones (default status for M2010, M2015 microphones)
  - DCR 5R range → 1.4 mA current to measure the output impedance of the DUT (Device Under Test) (up to 5 kΩ)
  - DCR 100k range → 100 mA current to measure the output impedance of the DUT (up to 100 kΩ)
  - ICP* → constant current microphone power supply
- Bias Settling → idle time before the measurement can start after activation of an input channel ⇒ thus, the DUT can settle to the active bias
- MicSensitivity → the sensitivity of the connected microphone
- Shunt Resistor → the impedance of a connected shunt resistor (e.g. 1 Ω for FX-SIL or 20 Ω for external RT-IB 100V)
- Voltage Divider → the ratio of a connected voltage divider (e.g.4.93 for RT-IB 100V)

**: ICP® is a registered trademark of PCB Piezotronics*

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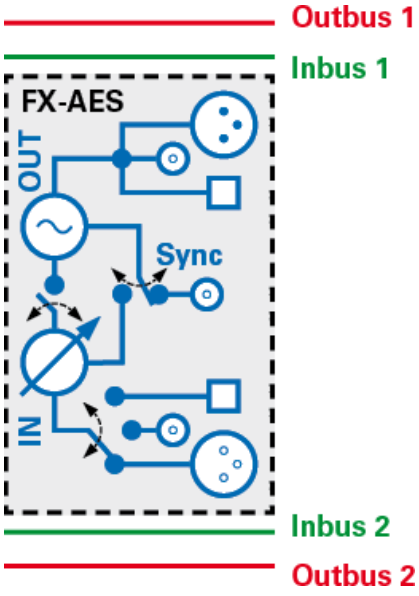
2.8 FX-AES board

FX-AES is a 2-channel digital audio generator & analyzer

- The board supports the generation and analysis of Meter, StepSweep or GlideSweep test signals and measurements
- The sampling clock can be generated internally or synchronized to an external source
- In case of StepSweep or GlideSweep measurements, both channels always start simultaneously
- FX-AES must be installed together with a FX-GEN and FX-ANA board

FX-AES internal schematic



The internal wiring of the FX-AES board can be edited in the Hardware & Wiring view.

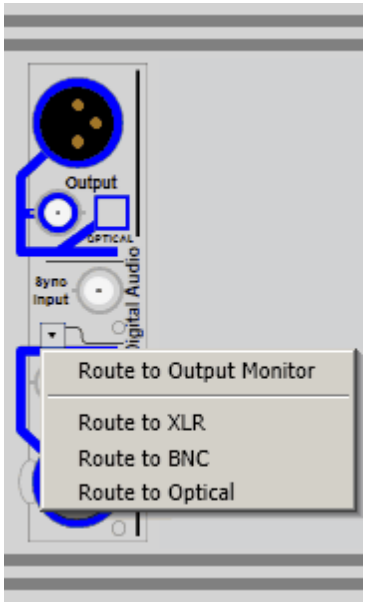
The digital audio generator is permanently linked to the XLR, BNC, TOSLINK connectors

The digital audio analyzer can be linked alternatively to the

- XLR input connector
- BNC input connector
- TOSLINK input connector

Furthermore, you can

- click on the symbol of the digital audio analyzer and select the required status, or
- amend the corresponding settings via the properties (*see below*),
- link the generator clock source to the BNC Sync Ref. Input or the analyzer input,
- link the analyzer directly to the generator in order to analyze in generated signal,
- select the impedance of the analyzer or sync input connectors.



Hint ***The digital audio generator, analyzer can not be connected to the internal audio bus of the FX100***

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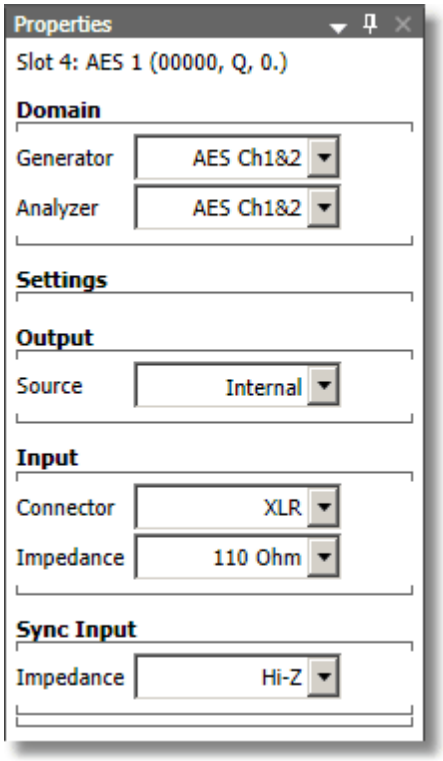
FX-AES properties



The FX-AES board has following properties

- Slot number: AES board number (PCB serial number, PCB version, PCB index)
- Domain of Generator, Analyzer (independently adjustable)
  - Analog → digital audio inactive
  - AES Ch1&2 → digital audio active on both channels
- Output settings → Source
  - Internal → the digital audio generator uses to its own clock source
  - AESInputRecovered → the digital audio generator synchronizes to the clock of the signal at the analyzer input
  - SyncInput → the digital audio generator synchronizes to the clock of the Sync Ref. Input connector
- Input settings → Connector
  - XLR → analyzer linked to XLR input connector
  - BNC → analyzer linked to BNC input connector
  - Optical → analyzer linked to TOSLINK input connector
  - AES Output Monitor → analyzer directly linked to digital audio generator
- Input settings → Impedance
  - 110 Ohm → impedance of input connectors 110 Ω
  - 75 Ohm → impedance of input connectors 75 Ω
  - Hi-Z → impedance of input connectors >10 kΩ
- Sync Input → Impedance
  - Hi-Z → impedance of Sync Ref. Input connector >10 kΩ
  - 75 Ohm → impedance of Sync Ref. Input connector 75 Ω

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2.9 FX-SIL option

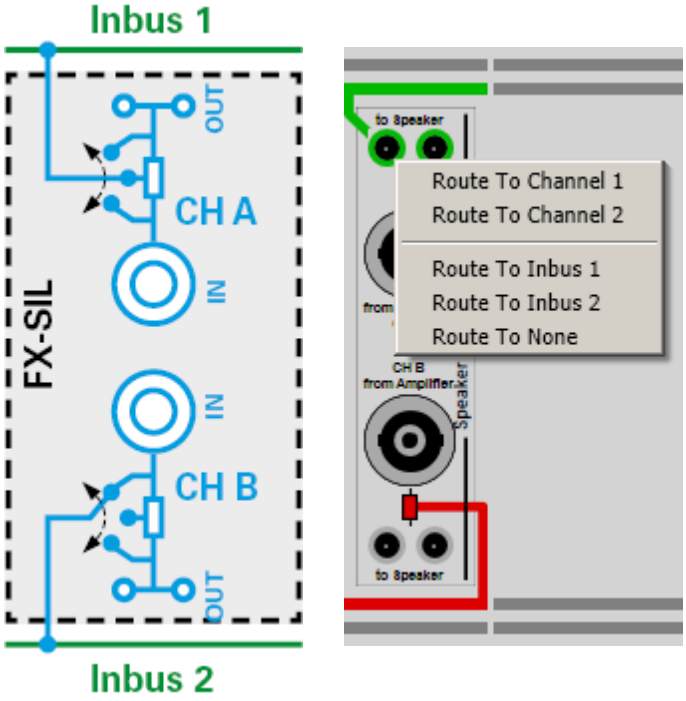
The FX-SIL plug-in board is used to measure either

a) the AC-impedance of the connected loudspeaker(s) via two high-precision 1 Ω shunt resistors, or

b) the DC resistance of the connected loudspeaker(s) by feeding a small current through the DUT.

NOTE An external amplifier is required to measure the loudspeaker impedance with the FX-SIL board; alternatively, you may use the FX-SIP board.
The maximum current through the FX-SIL option is 1 A

FX-SIL internal schematic

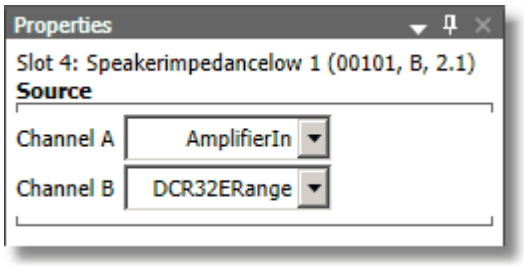


The FX-SIL elements can be routed internally as follows

- Speakon™ IN to
  - Channel 1, 2 of the analyzer → required link to measure or equalize the amplifier output voltage
  - None (*i.e. no connection*)
- Shunt resistor 1, 2 to
  - Channel 1, 2 respectively → required link to measure the AC-impedance of a connected DUT (Device Under Test)
  - None (*i.e. no connection*)
- Banana output connectors to
  - Inbus 1, 2 → measure the DCR of the DUT, or equalize the actual driving voltage.
  - None (*i.e. no connection*)

Right-click on any symbol in the Hardware & Wiring view to link it as required.

FX-SIL properties



The FX-SIL board has the following properties

- Slot number: SpeakerImpedanceLow number (PCB serial number, PCB version, PCB index)
- Source
  - AmplifierIn → Speakon™ IN connected to amplifier output
  - Protected → Speakon™ IN disconnected from internal circuit, e.g. due to an overflow
  - DCR32ERange → internal current source of the SIL is active (is used to measure the DC impedance of the connected DUT in the range from 1.5 to 1500 Ω)

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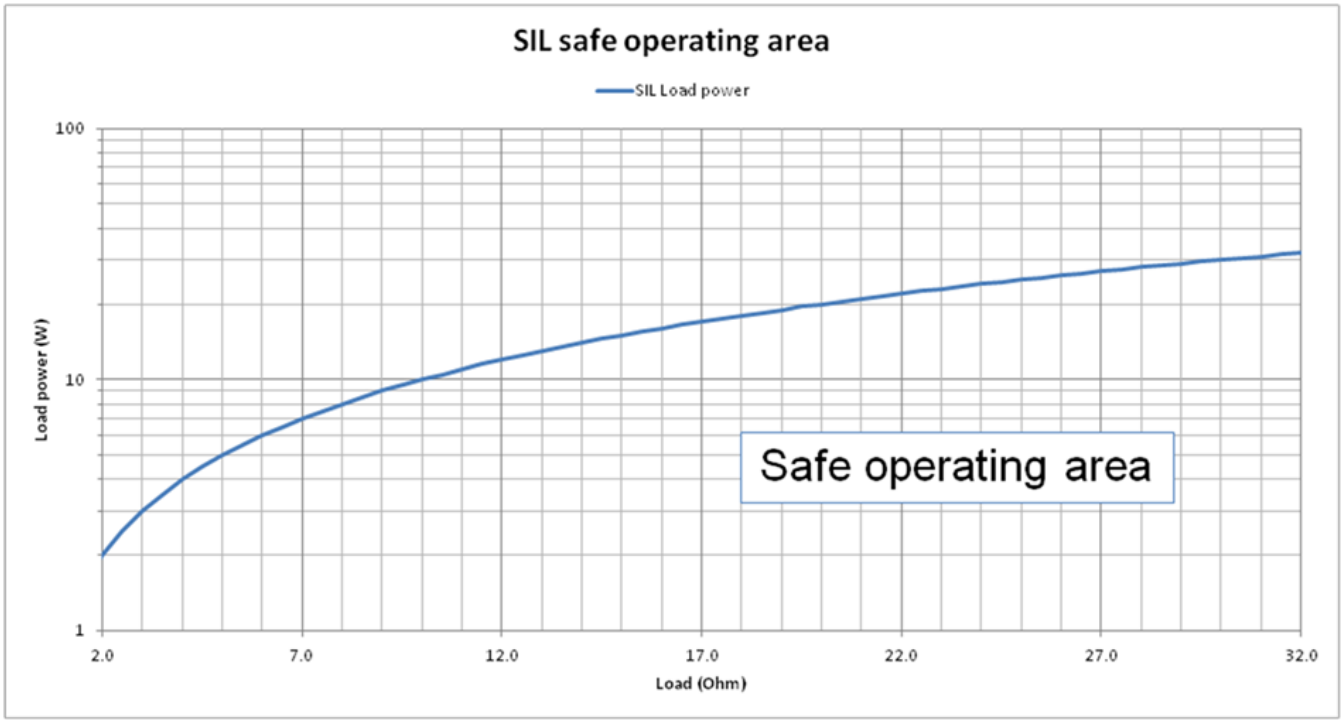
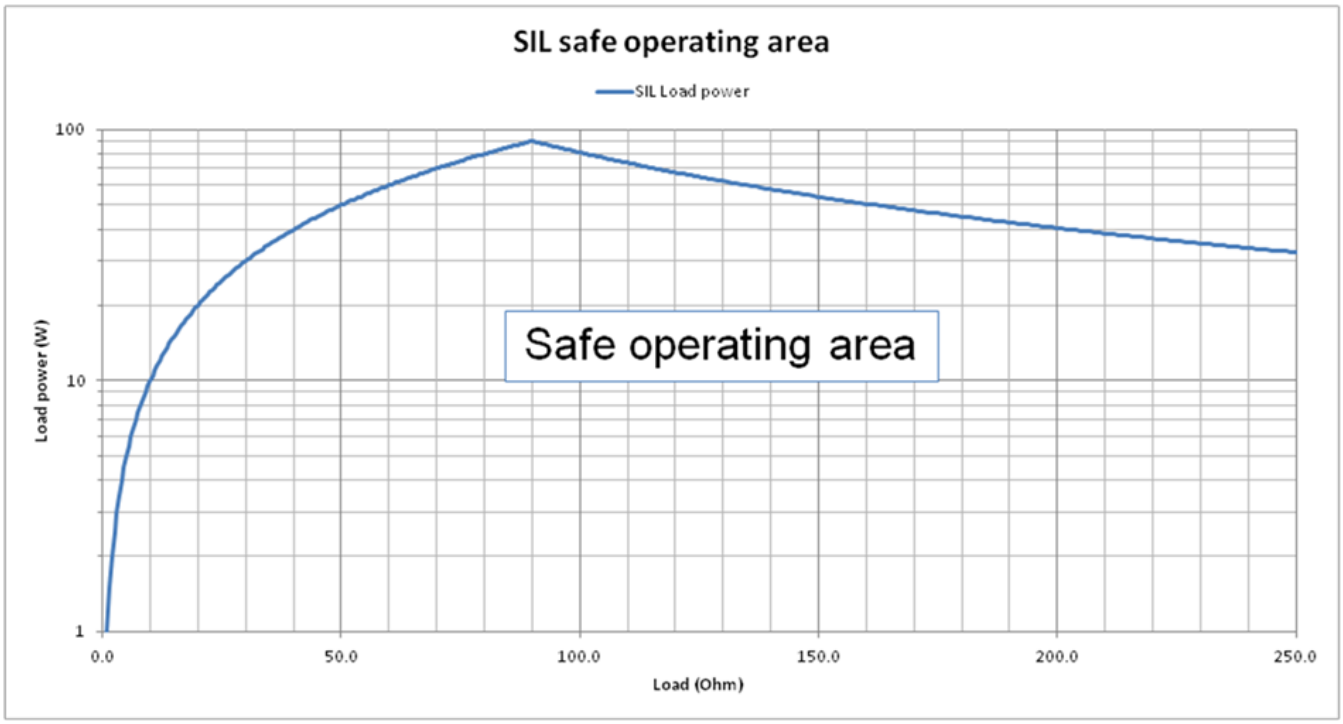
Safe operating area



Safe operating are for loads from 2...32 Ω



Safe operating are for loads from 2...250 Ω

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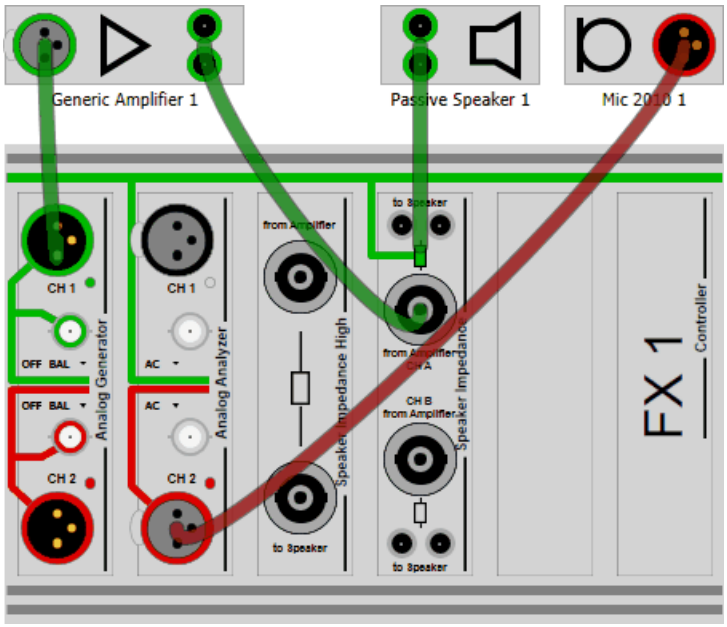
Application examples

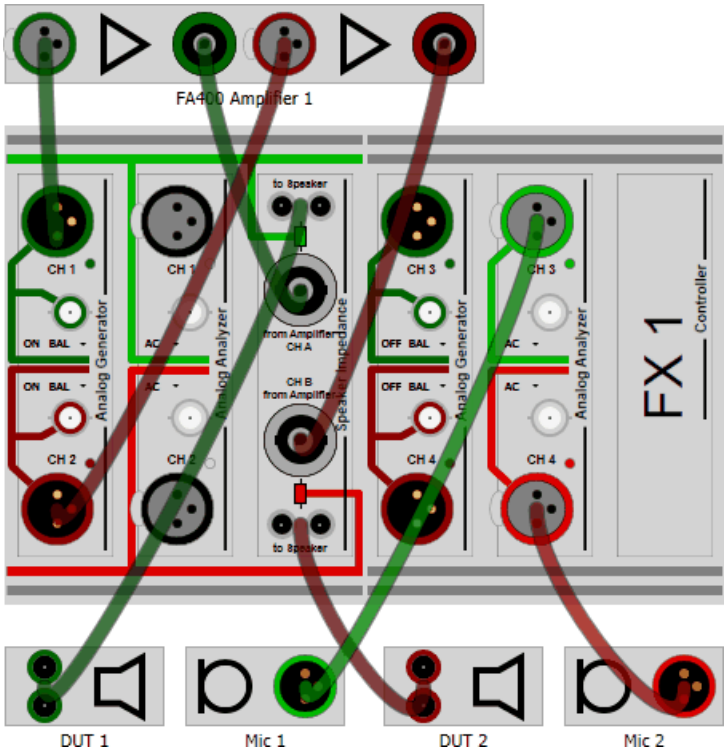
a) AC-Impedance measurement (1 speaker)



Wiring example: simultaneous measurement via FX-SIL of speaker AC-impedance / acoustic performance

NOTE For an AC-Impedance measurement, you have to set the Analyzer Coupling to "AC", and the FX-SIH property to "Amplifier".

b) AC-Impedance measurement (2 speakers in parallel)



Wiring example: simultaneous measurement via FX-SIL of 2 speakers AC-impedance / acoustic performance

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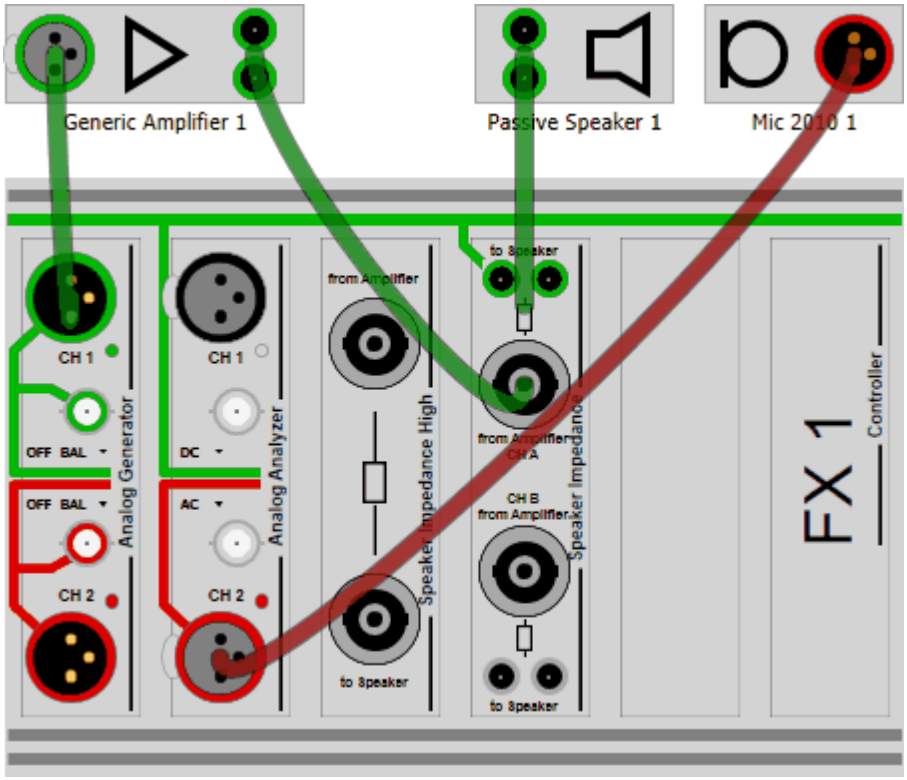
c) DCR measurement (1 speaker)



FX-SIL wiring example for DCR measurement (1 speaker)

NOTE **For a DCR measurement, you have to set the Analyzer Coupling to "DC", and the FX-SIL property to "DCR32ERange".**

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2.10 FX-SIH option

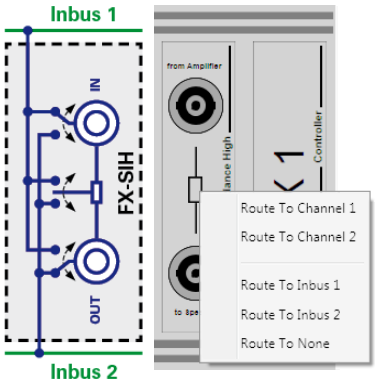
The FX-SIH plug-in board is used to measure either

a) the AC-impedance of the connected loudspeaker via two high-precision 0.1 Ω shunt resistors, or

b) the DC resistance of the connected loudspeaker by feeding a small current through the DUT

NOTE An external amplifier is required to measure the loudspeaker impedance with the FX-SIH board; alternatively, you may use the FX-SIP board.
The maximum current through the FX-SIH option is 10 A
The Speakon™ output connector comprises four pins, two for the signal and two for the sense line (refer to the application example below)

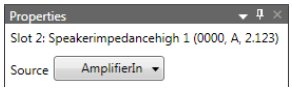
FX-SIH internal schematic



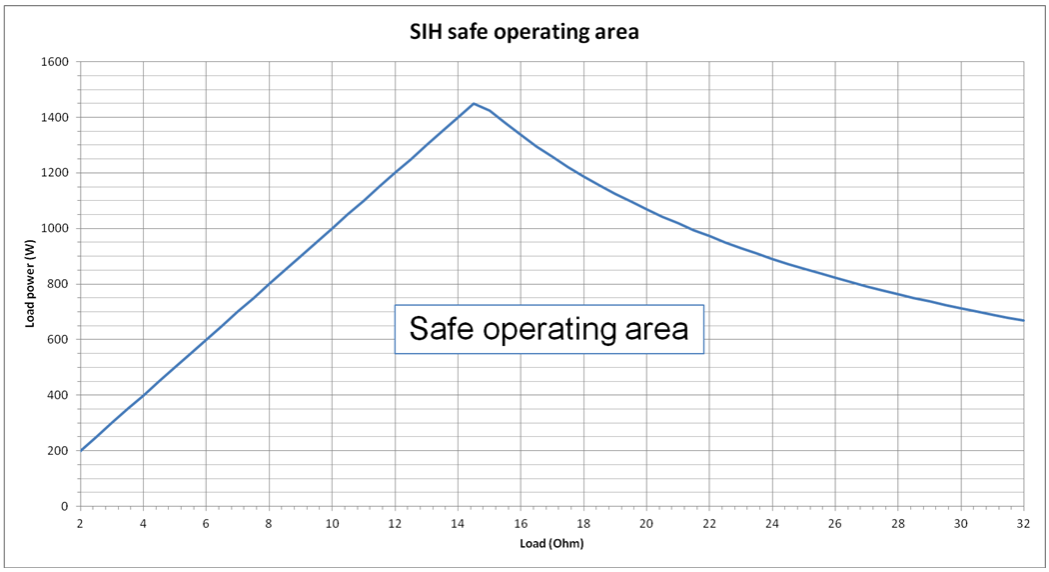
The FX-SIH can be linked internally as follows

- Speakon™ IN to Inbus 1, 2 → e.g. to measure or equalize the amplifier output voltage
- Shunt resistor to Inbus 1, 2 → this link is required for measuring the AC-impedance of a connected DUT (Device Under Test)
- Speakon™ OUT to Inbus 1, 2 → measure the DCR of the DUT, or equalize the actual driving voltage

FX-SIH properties



- Slot number: SpeakerImpedanceHigh number (PCB serial number, PCB version, PCB index)
- Source
  - AmplifierIn → Speakon™ IN connected to amplifier output
  - DCR4Erange → internal current source of the SIH is active (is used to measure the DC impedance of the connected DUT in the range from 2 to 100 Ω)



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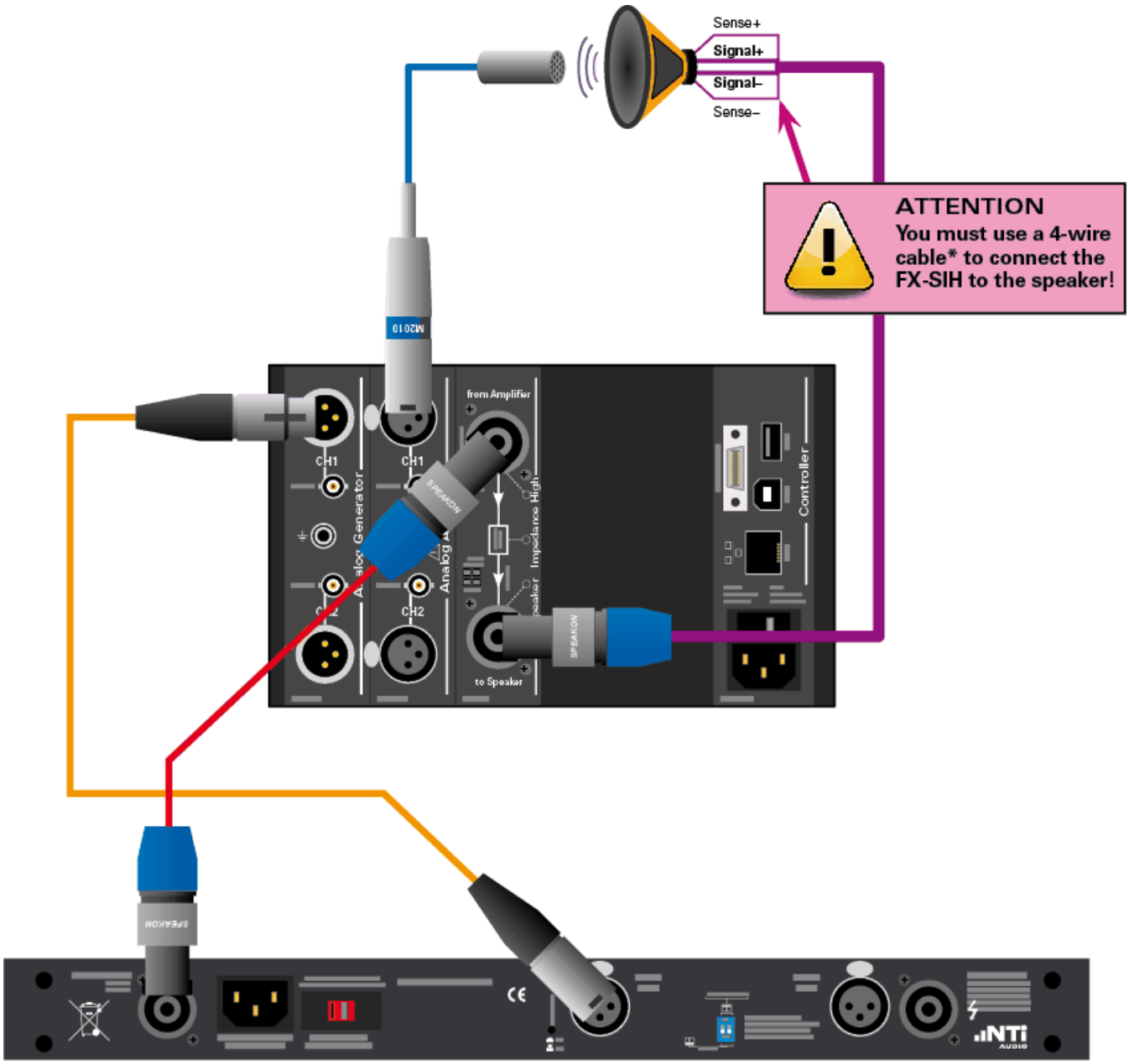
Application examples

a) Cable connections



Example of cable connections between FX100, FX-SIH option, FA400 audio amplifier and M2010 microphone

*: Speakon™ pin assignment

- 1+ Speaker+ (signal)
- 1– Speaker– (signal)
- 2+ Sense+
- 2– Sense–

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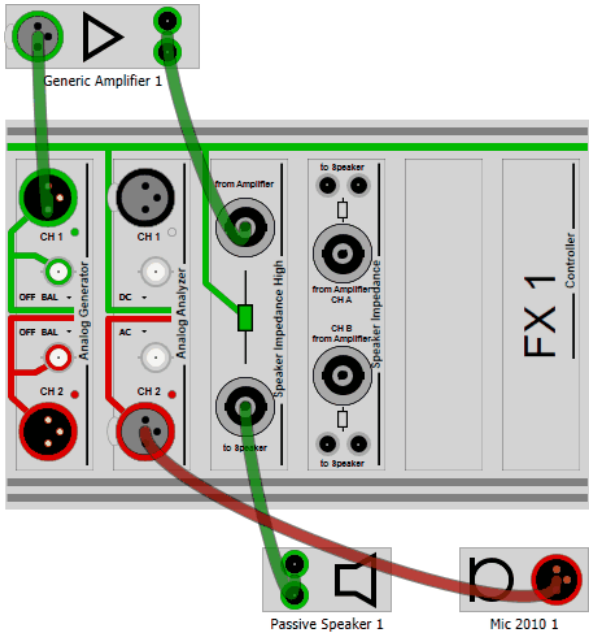
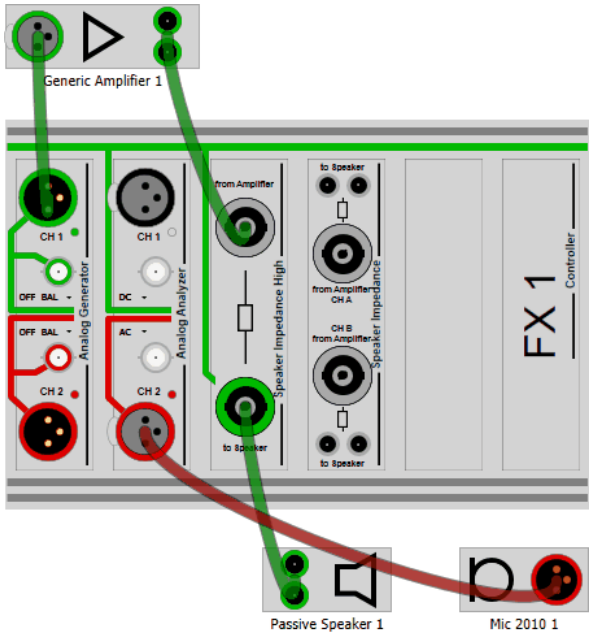
b) AC-Impedance measurement



Wiring example: simultaneous measurement via FX-SIH of speaker AC-impedance / acoustic performance

NOTE For an AC-Impedance measurement, you have to set the Analyzer Coupling to "AC", and the FX-SIH property to "Amplifier".

c) DCR measurement



Wiring example for DCR measurement via FX-SIH

NOTE For a DCR measurement, you have to set the Analyzer Coupling to "DC", and the FX-SIH property to "DCR4ERange".

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2.11 FX-SIP option

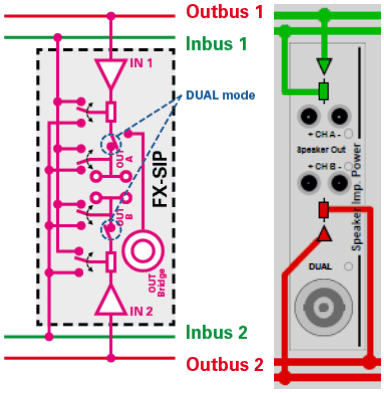
The FX-SIP plug-in board provides all required components to execute a complete loudspeaker test, i.e.

- Power amplifier (0 dB gain):
  - DUAL mode: 2-chn @ 10 W
  - BRIDGE mode: 1-chn @ 30 W
- Current sensor: DC and AC, 0 to 250 Ω

NOTE The Speakon™ output connector comprises four pins, two for the signal and two for the sense line (refer to the application example below)

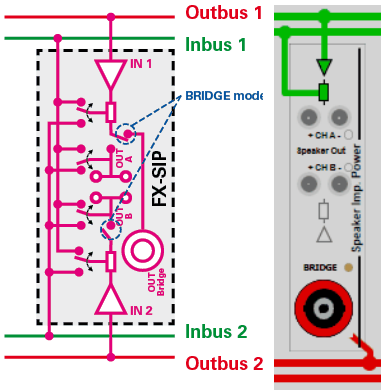
FX-SIP internal schematic

Depending on the operation mode, the FX-SIP elements can be routed internally as described below.



a) DUAL mode

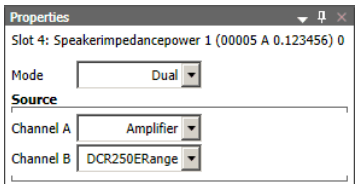
- Amplifier In A / B to
  - Outbus 1 / 2 respectively
  - None (*i.e. no connection*)
- Shunt A, B to
  - Inbus 1 or 2
  - None (*i.e. no connection*)
- Banana output connectors to
  - Inbus 1, 2 → measure the DCR of the DUT, or equalize the actual driving voltage.
  - None (*i.e. no connection*)



b) BRIDGE mode

- Amplifier In to
  - Outbus 1
  - None (*i.e. no connection*)
- Shunt A to
  - Inbus 1 or 2
  - None (*i.e. no connection*)
- Speakon™ OUT to Inbus 1, 2 → measure the DCR of the DUT, or equalize the actual driving voltage

FX-SIP properties



- Slot number: SpeakerImpedancePower number (PCB serial number, PCB version, PCB index)
- Mode
  - Dual (2-chn operation: 2*10 W into 2 Ω / 4 Ω)
  - Bridge (1-chn operation: 1*30 W into 2 Ω / 4 Ω)
- Source of Channel A, B
  - Amplifier
  - DCR250ERange → internal current source of the SIP is active (is used to measure the DC impedance of the connected DUT in the range from 0 to 250 Ω)

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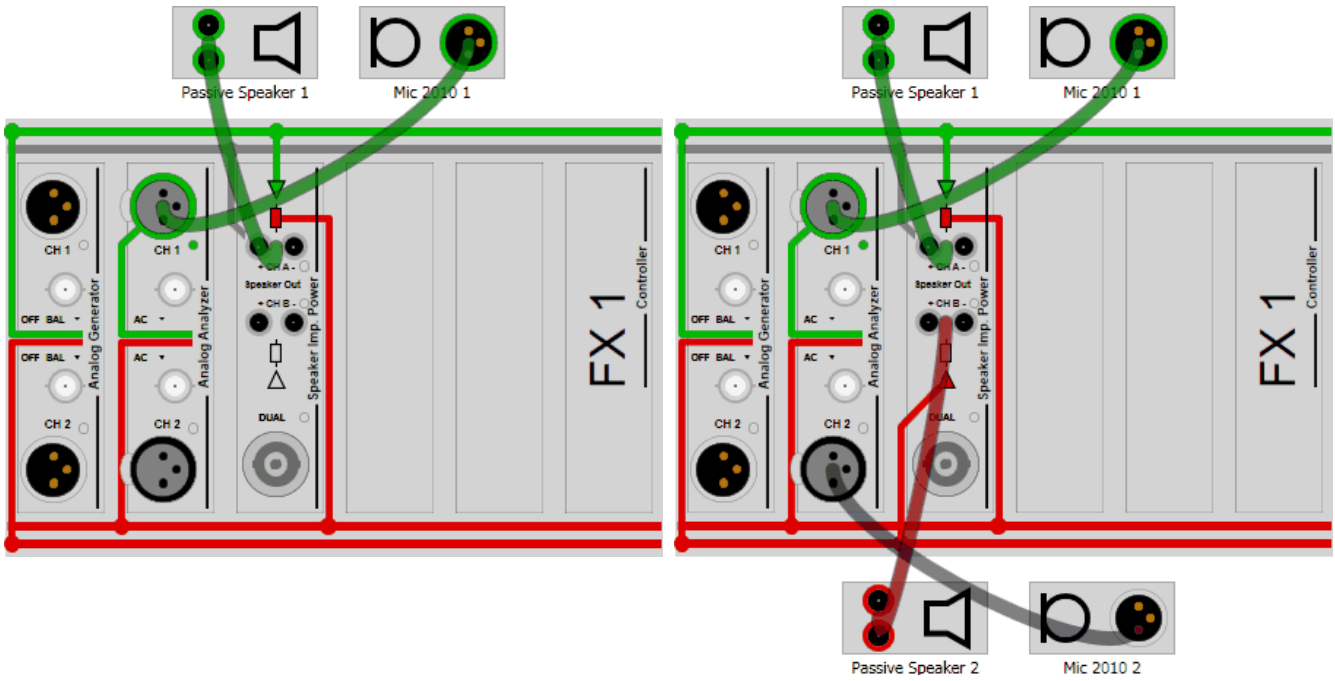
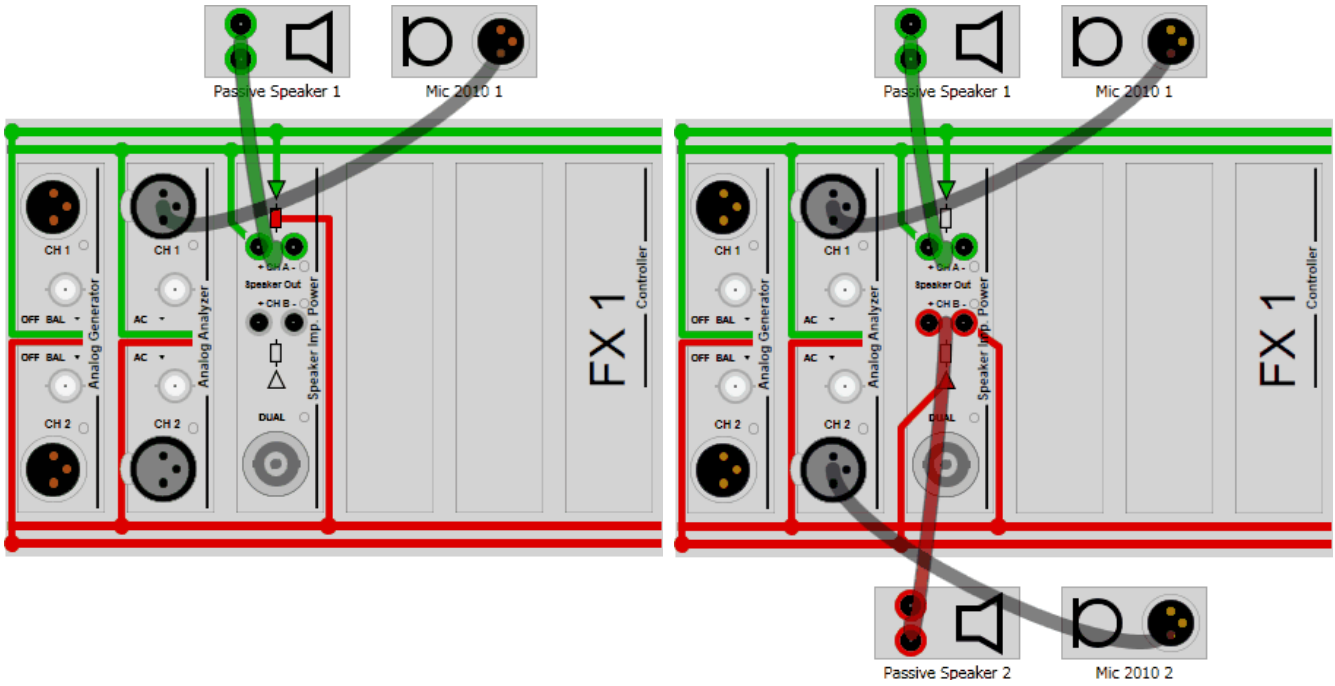
A) DUAL mode application examples

Hint ***In case of a 2-speaker setup, you have to execute the tests either by using the sequence mode or a 4-channel FX100 system.***

A1. Frequency & impedance response



A2. DCR



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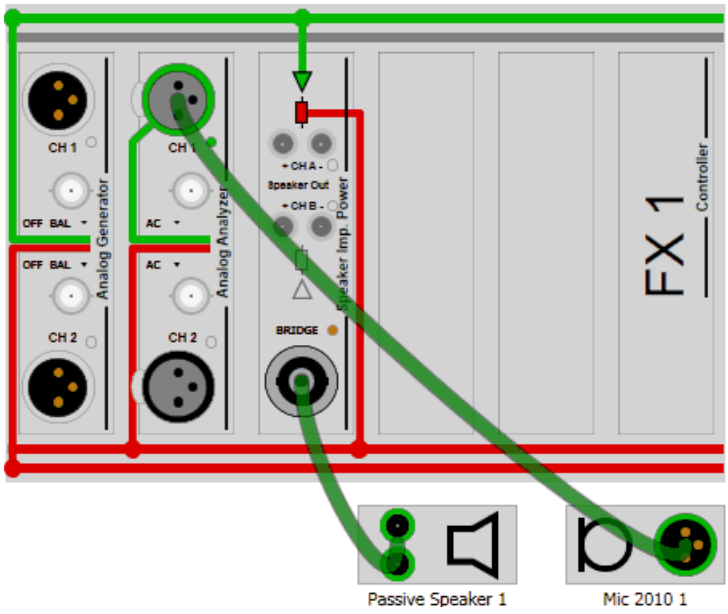
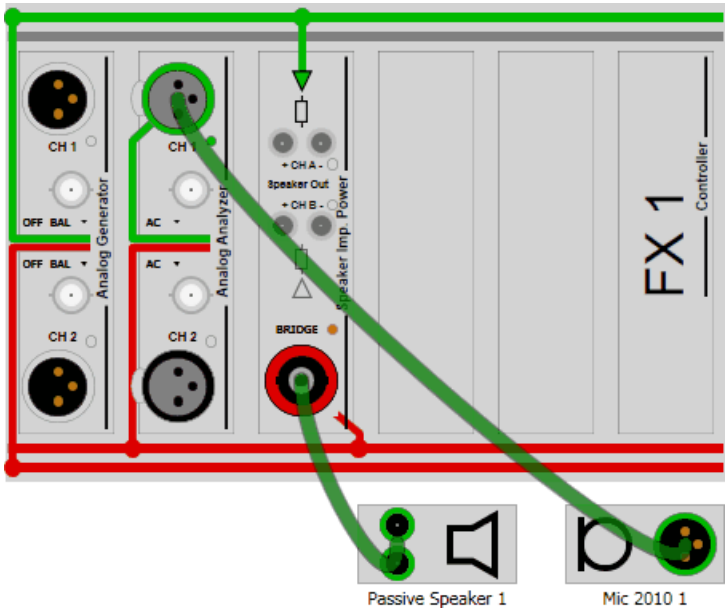
B) BRIDGE mode application examples

Hint ***You must use a 4-wire cable* to connect the FX-SIP with the loudspeaker***

B1. Frequency & impedance response



B2. DCR



*: Speakon™ pin assignment

- 1+ Speaker+ (signal)
- 1– Speaker– (signal)
- 2+ Sense+
- 2– Sense–

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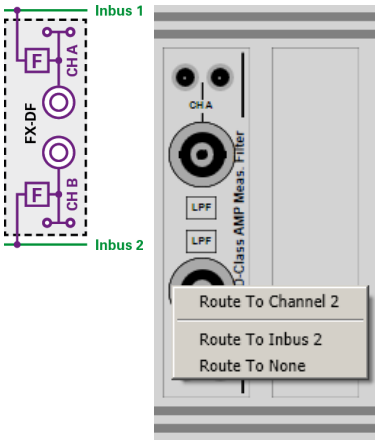
2.12 FX-DF option

The FX-DF board allows to measure the performance of D-class amplifiers. It includes one low-pass filter per channel that cuts off the amplifier noise beyond 20 kHz. The DF-option thus keeps away the impact of the amplifier's switching circuitry from the measurement results in the audio band.

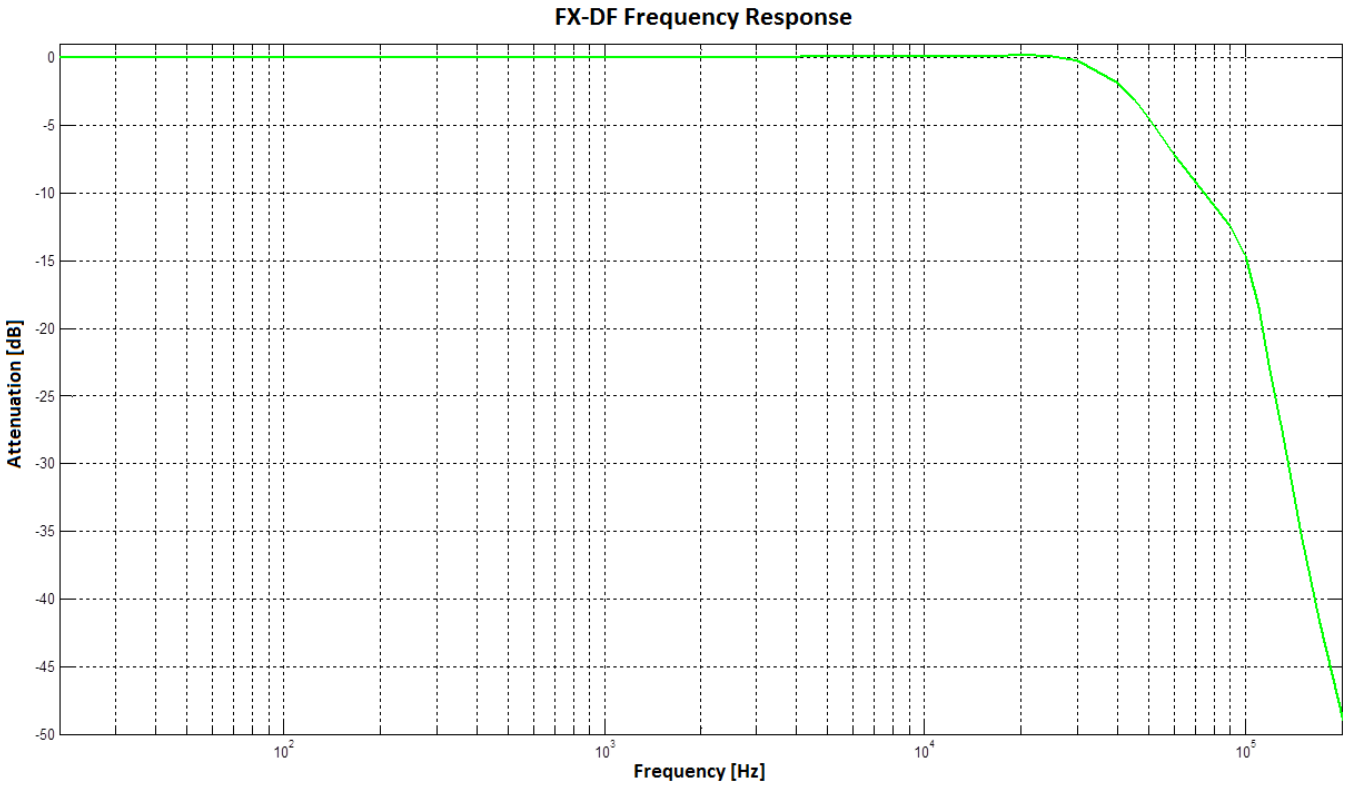
FX-DF internal schematic



The FX-DF can be linked internally as follows:

- Banana or Speakon™ input CH A via the low-pass filter to Inbus 1
- Banana or Speakon™ input CH B via the low-pass filter to Inbus 2

FX-DF properties



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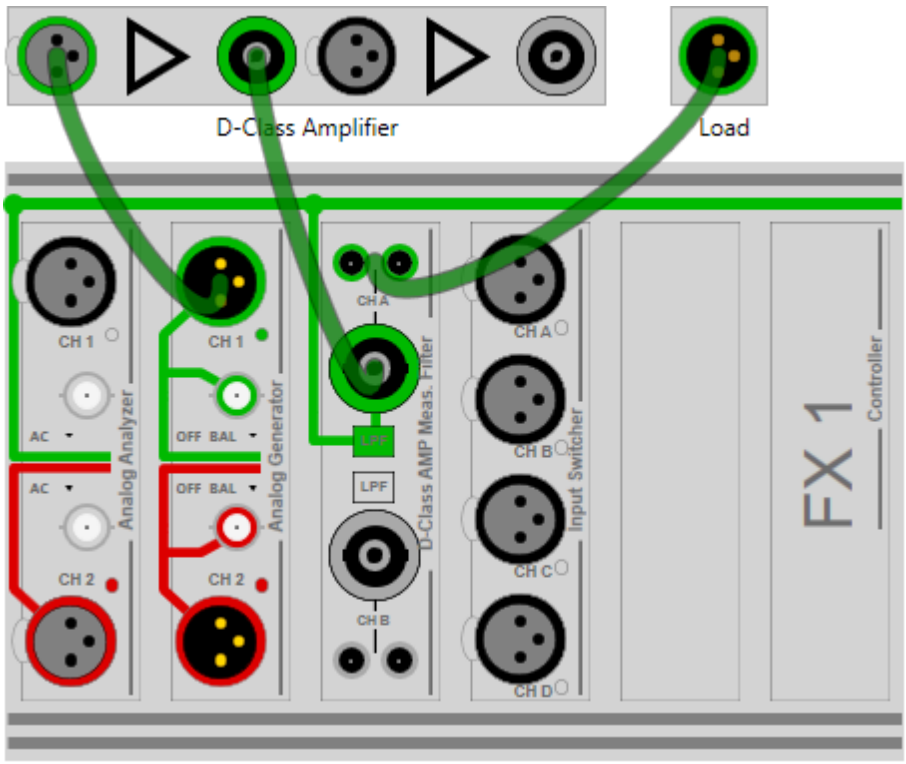
Application example



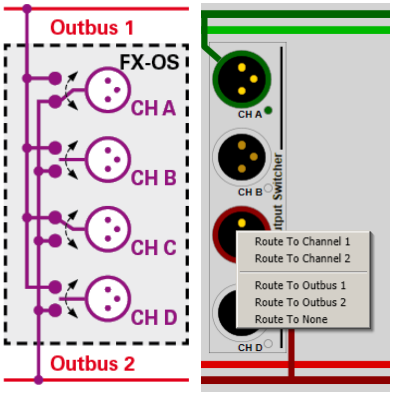
Wiring example: D-class amplifier and load connected to FX-DF board

2.13 FX-OS option

The FX-OS output switcher plug-in board is used to add 4 additional output connectors to the FX100 generator channels.

- The link between the FX100 generator and an FX-OS connector is established via the Outbus 1, 2
- Either or both generator output channels 1, 2 can be linked to any available FX-OS output connector.
- The current generator coupling is applied via the Outbus on the active FX-OS connector
- Up to three FX-OS boards can be installed in the FX100 (max. 12 switched output channels)

FX-OS internal schematic



Right-click on any XLR output connector to

- link it to Outbus 1, 2 or any generator channel, or
- switch it to idle mode

Hint ***Only one of either Outbus 1 or 2 can be linked to one output connector at a time***

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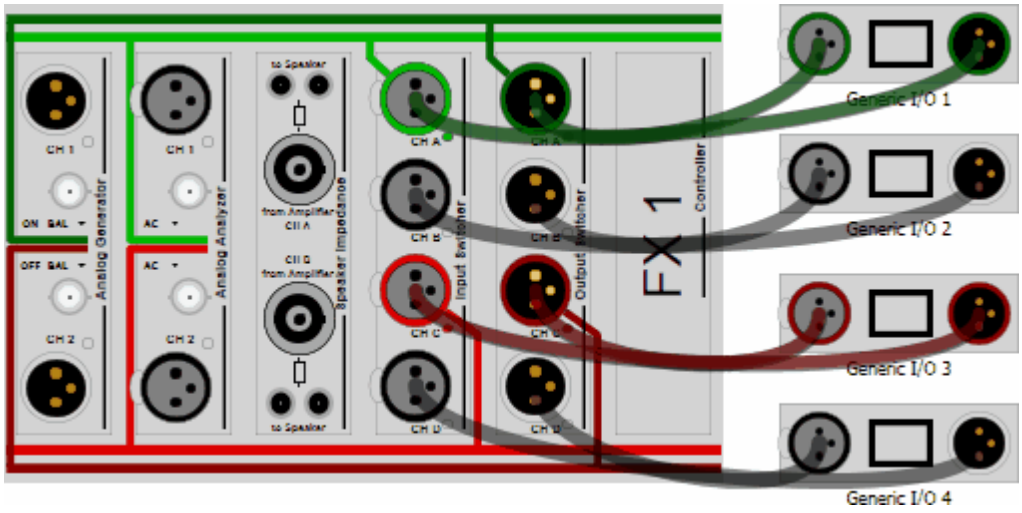
FX-OS properties

The FX-OS has no editable properties

- Slot number: OutSwitcher number (PCB serial number, PCB version, PCB index)

Application example



FX-OS application example: switched testing of a 4chn device

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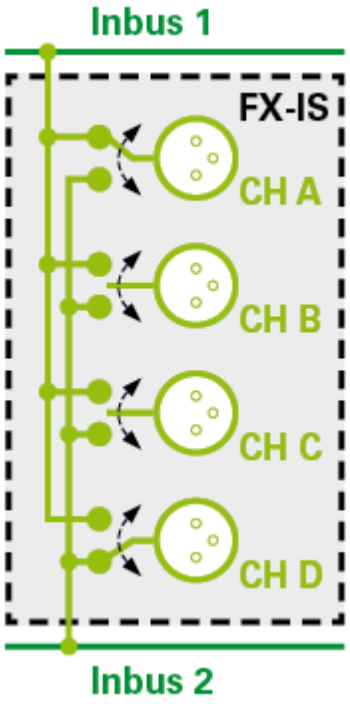
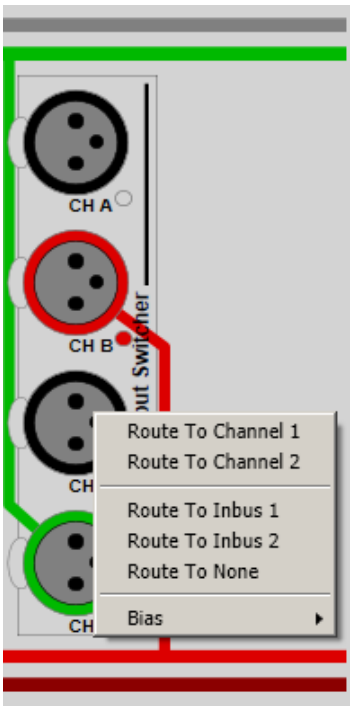
2.14 FX-IS option

The FX-IS input switcher board is used to add 4 additional input channels to the FX100 analyzer.

- The link between an FX-IS connector and the FX100 analyzer is established via the Inbus 1, 2
- Any or all FX-IS input connectors can be linked to any available analyzer channel
- An individual bias (e.g. Phantom power) can be activated for each FX-IS connector
- Up to three FX-IS boards can be installed in the FX100 (max. 12 switched input channels)

FX-IS internal schematic





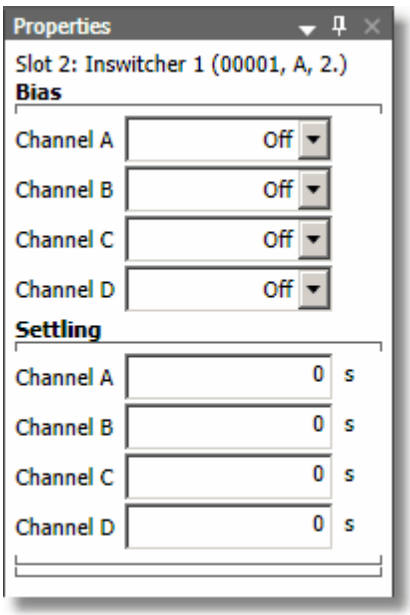
Right-click on any XLR input connectors to

- link it to Inbus 1, 2 or any analyzer channel, or
- switch it to idle mode

Furthermore, an individual bias can be activated on each input connector.

Hint ***Only one of either Inbus 1 or 2 can be linked to one input connector at a time***

FX-IS properties



The FX-IS has the following properties

- Slot number: InSwitcher number (PCB serial number, PCB version, PCB index)
- Bias → optional offset voltage or current that is applied to the input connector(s)
  - 2V → Phantom power for 2 V microphones
  - 48V → Phantom power for 48 V microphones (default status for M2010, M2015 microphones)
  - DCR 5k range → 1.4 mA current to measure the output impedance of the DUT (Device Under Test) (up to 5 kΩ)
  - DCR 100k range → 100 µA current to measure the output impedance of the DUT (up to 100 kΩ)
  - ICP* → constant current microphone power supply
- Settling → idle time before the measurement can start after activation of an input channel ⇒ thus, the DUT can settle to the active bias

**: ICP® is a registered trademark of PCB Piezotronics*

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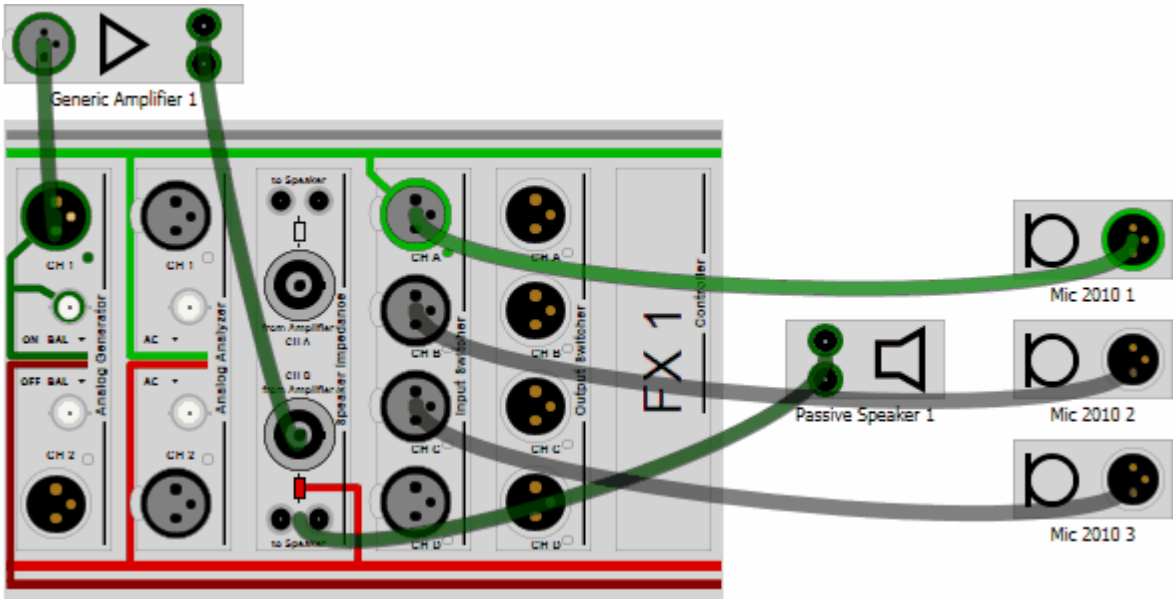
Application example



FX-IS application example: testing one loudspeaker with three switched microphones

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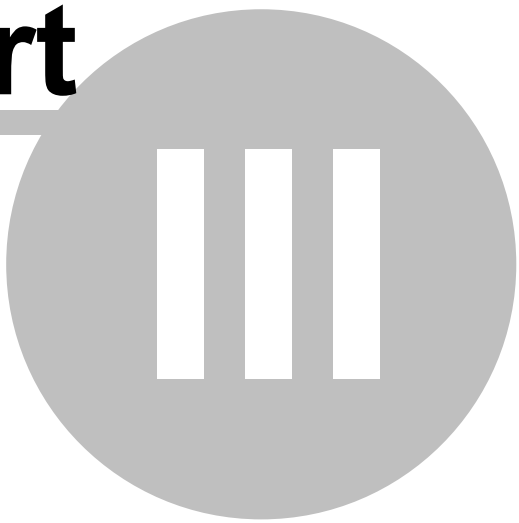
Part

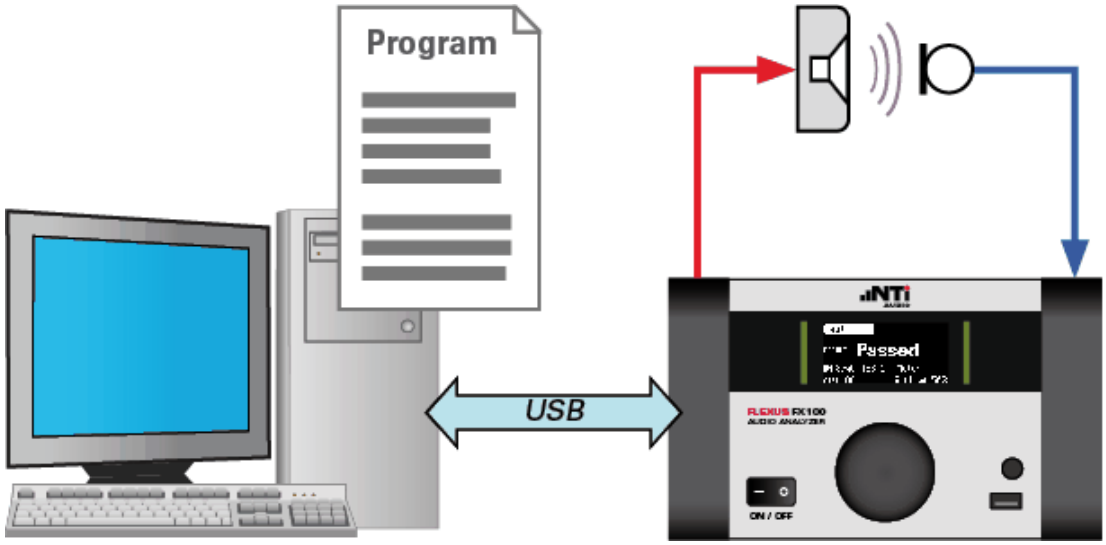


3 Software

The FX-Control software has been designed to handle two different operating modes of the FX100 audio analyzer.

Operating modes

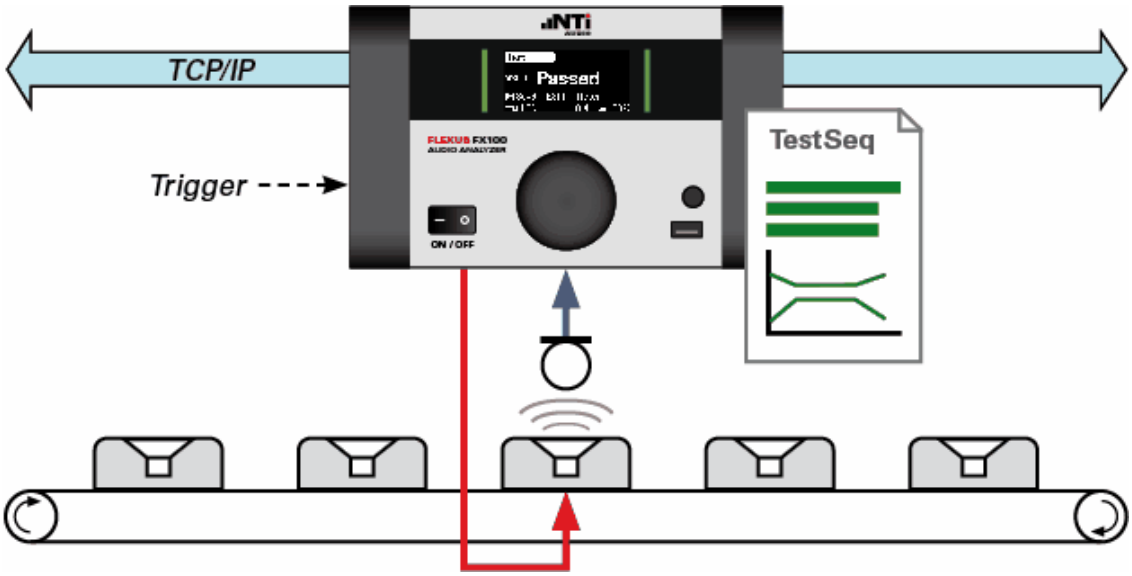
a) Remote control operation



The controller PC handles the instrument parameterization and test execution, and receives the uploaded result data

b) Stand-alone mode

NOTE Not implemented under firmware version 2.6x or lower



The FX100 instrument executes a customized test sequence (including PASS/FAIL rating) that has been previously defined & downloaded from a PC. Result data is transferred via TCP/IP link

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FX-Control PC-software

The basic tasks and operations of FX-Control can be divided into four areas.

i. System setup
   - Test parameters (generator adjustments)
   - Analyzer settings (e.g. input range, synchronization, triggering)
   - Measurement functions

ii. Acceptance criteria
   - Tolerance limits
   - PASS / FAIL indication

iii. Test execution
   - Single shot measurement
   - Continuous mode
   - Sequences

iv. Data logging
   - Custom settings
   - Data export

FX100 firmware

The FX100 Firmware performs the following tasks.

a) Execution of remote commands from the controller PC
b) Upload of result data to the controller PC
c) Handling of the front panel control elements (LCD, rotary encoder)
d) Stand-alone operation (not yet implemented)

The FX100 firmware can be updated via FX-Control or a USB stick.

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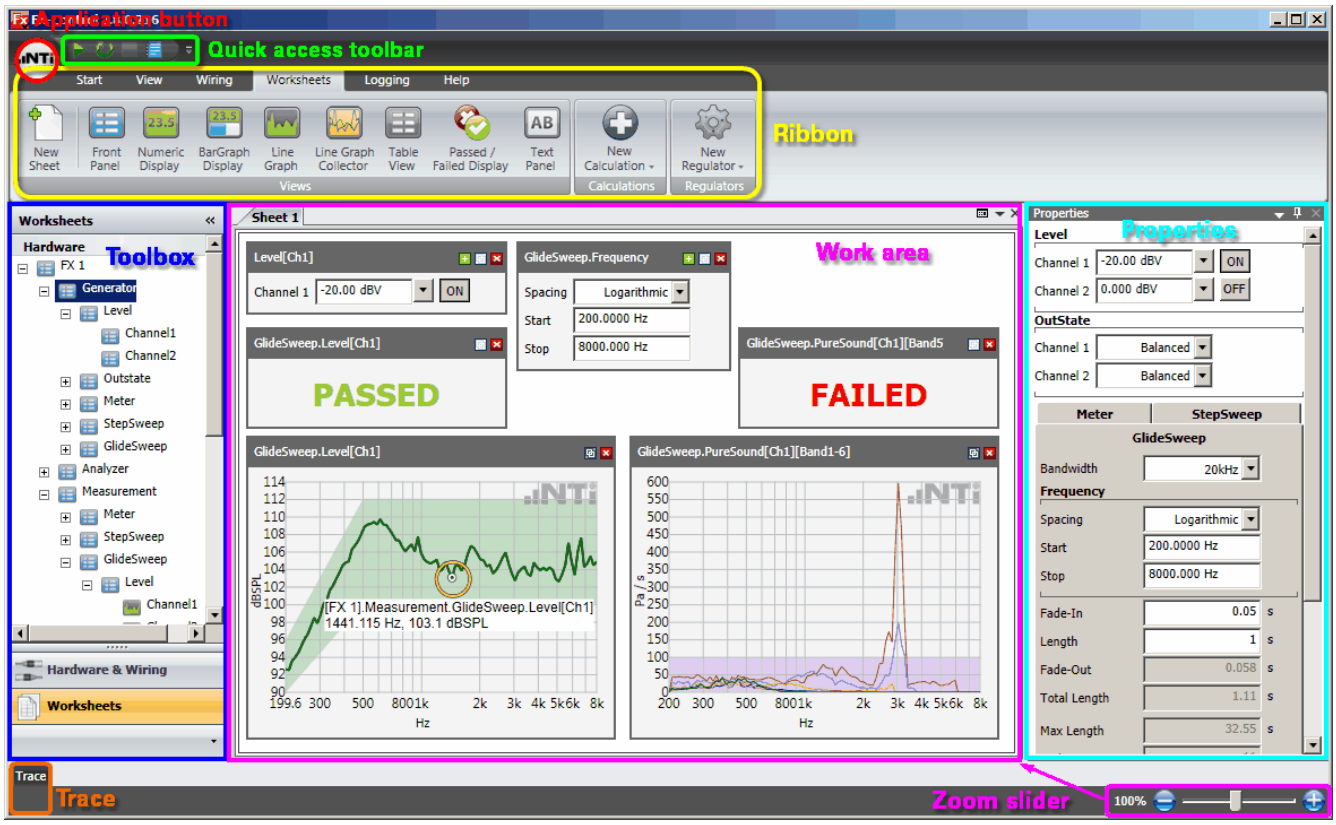
3.1 System operation

FX100 audio analyzer + FX-Control software are a comprehensive audio test system that covers a wide range of measurements and analysis.

FX-Control desktop



Hints ***The docking panels of FX-Control (e.g. Toolbox, WorkArea, Properties, Trace) can be arranged as floating, dockable, tabbed or auto-hide.***
The WorkArea can show either the Hardware & Wiring view or the Worksheet view

- Application button → project handling
- Quick access toolbar → customized key functions & buttons
- Ribbon → standard operation features
- Toolbox → list of elements for the Hardware & Wiring view or Worksheets
- WorkArea → design area for system wiring, test settings and result displays
- Properties → individual properties of the selected item in the Toolbox or Hardware & Wiring view or Worksheets

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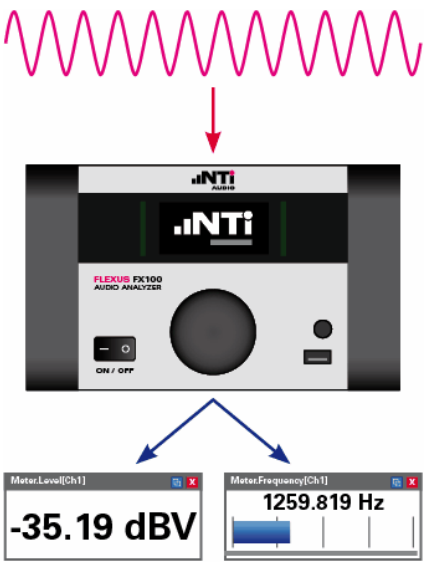
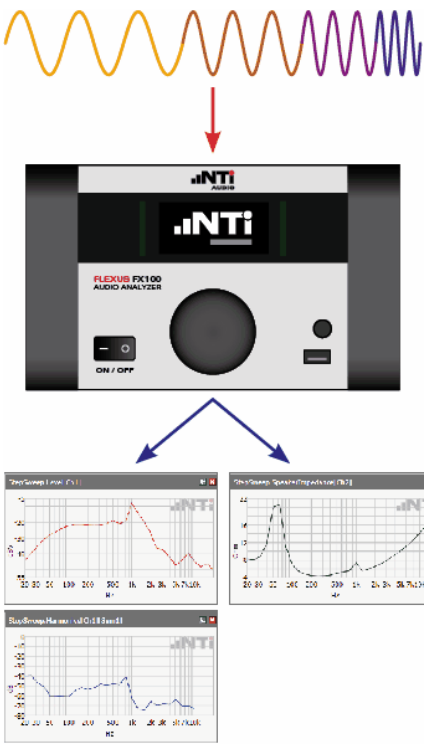
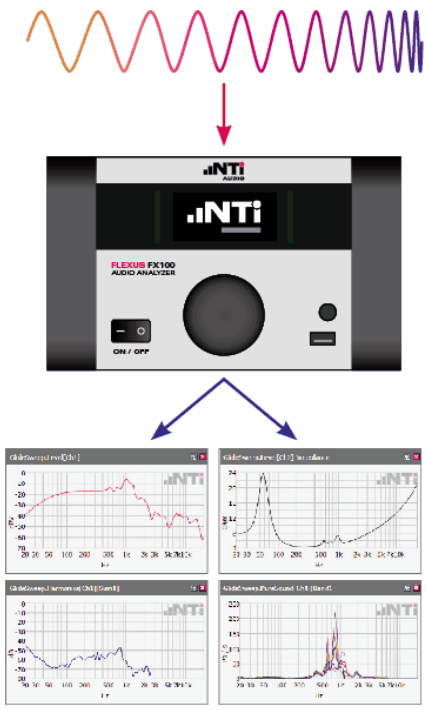
Measuring modes: Meter, StepSweep, GlideSweep

Meter	StepSweep	GlideSweep
 *'Steady state' analysis of the incoming signal*	 *FX100 analyzer measures the incoming signal and plots the results in a graph against frequency, level or time*	 *FX100 analyzer records incoming GlideSweep, calculates the measurement results and plots them in a graph*

Hint ***All three measuring modes support the analysis of test signals that come from the FX100 generator or from an external device.***

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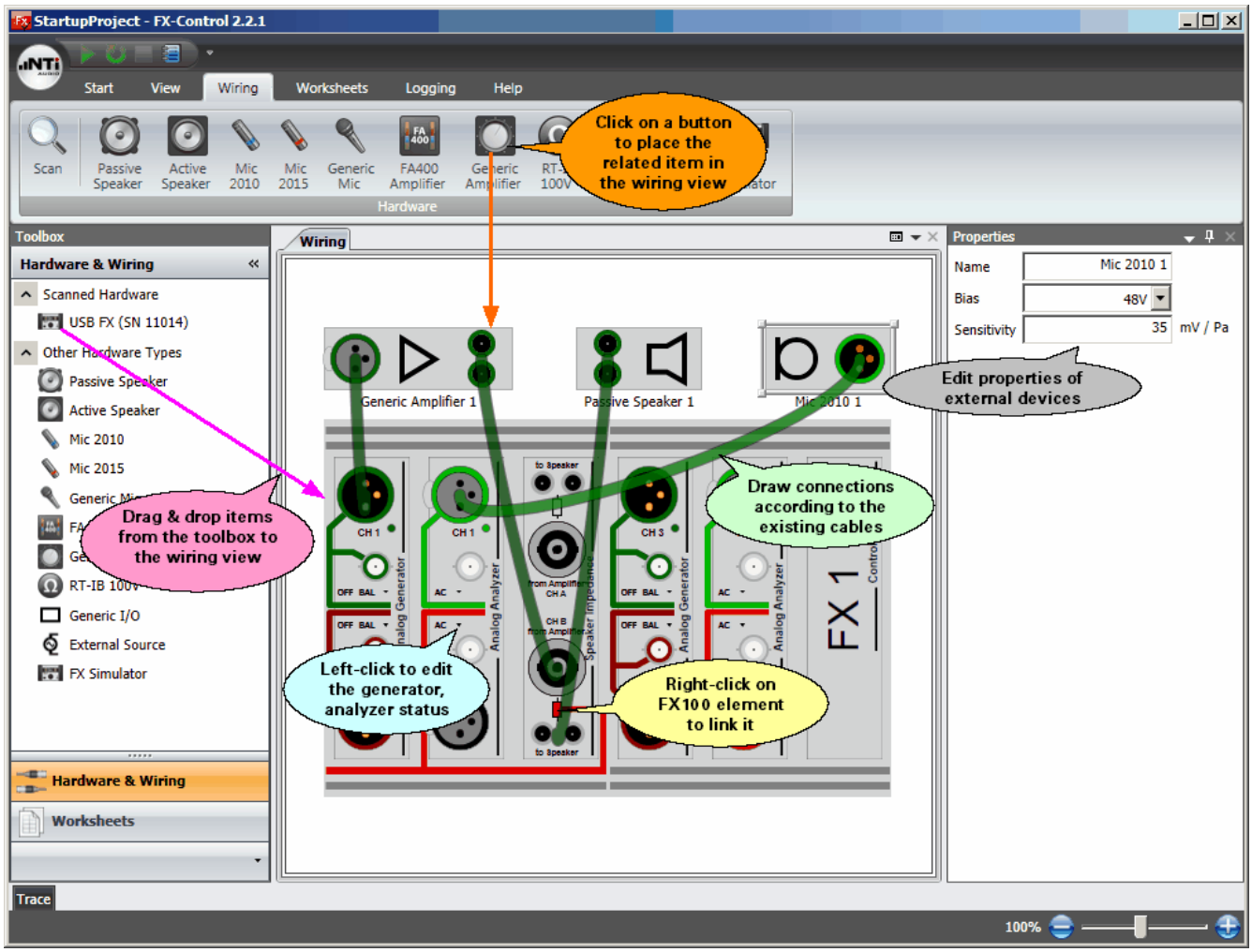
How to prepare a measurement

The following instructions demonstrate the procedure to set up a measurement with FX100.

Step 1 - Edit the wiring

- Click on a button in the ribbon or drag & drop an item from the toolbox to the wiring view to add the corresponding external device
- Optionally edit the properties of the external devices
- Draw the cable connections and activate the internal links
- Adjust the states of the generator / analyzer connectors



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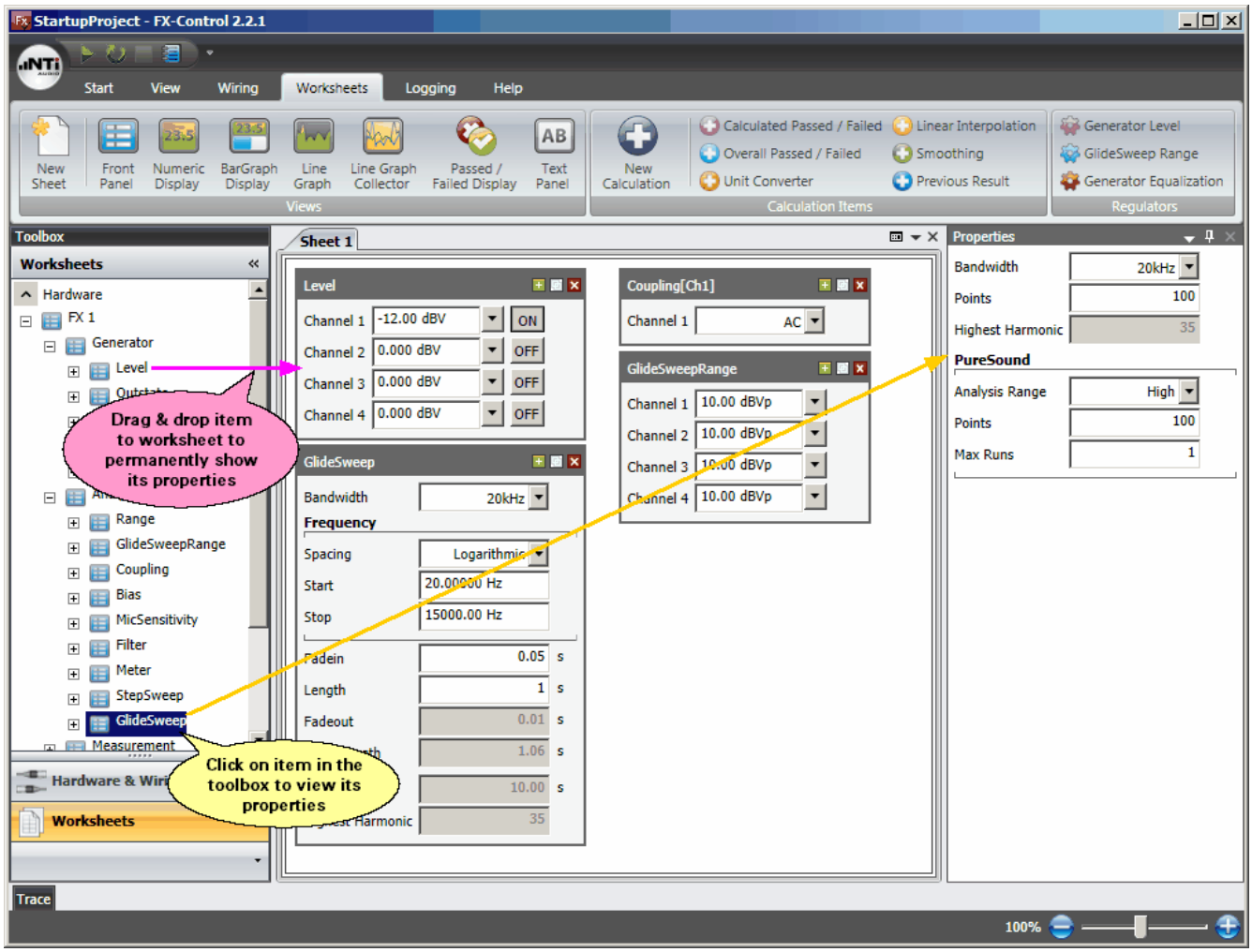
Step 2 - Adjust the test parameters

- Drag & drop the required generator / analyzer panels from the toolbox to the WorkArea
- Adjust the generator / analyzer properties in the corresponding panel or in the properties section



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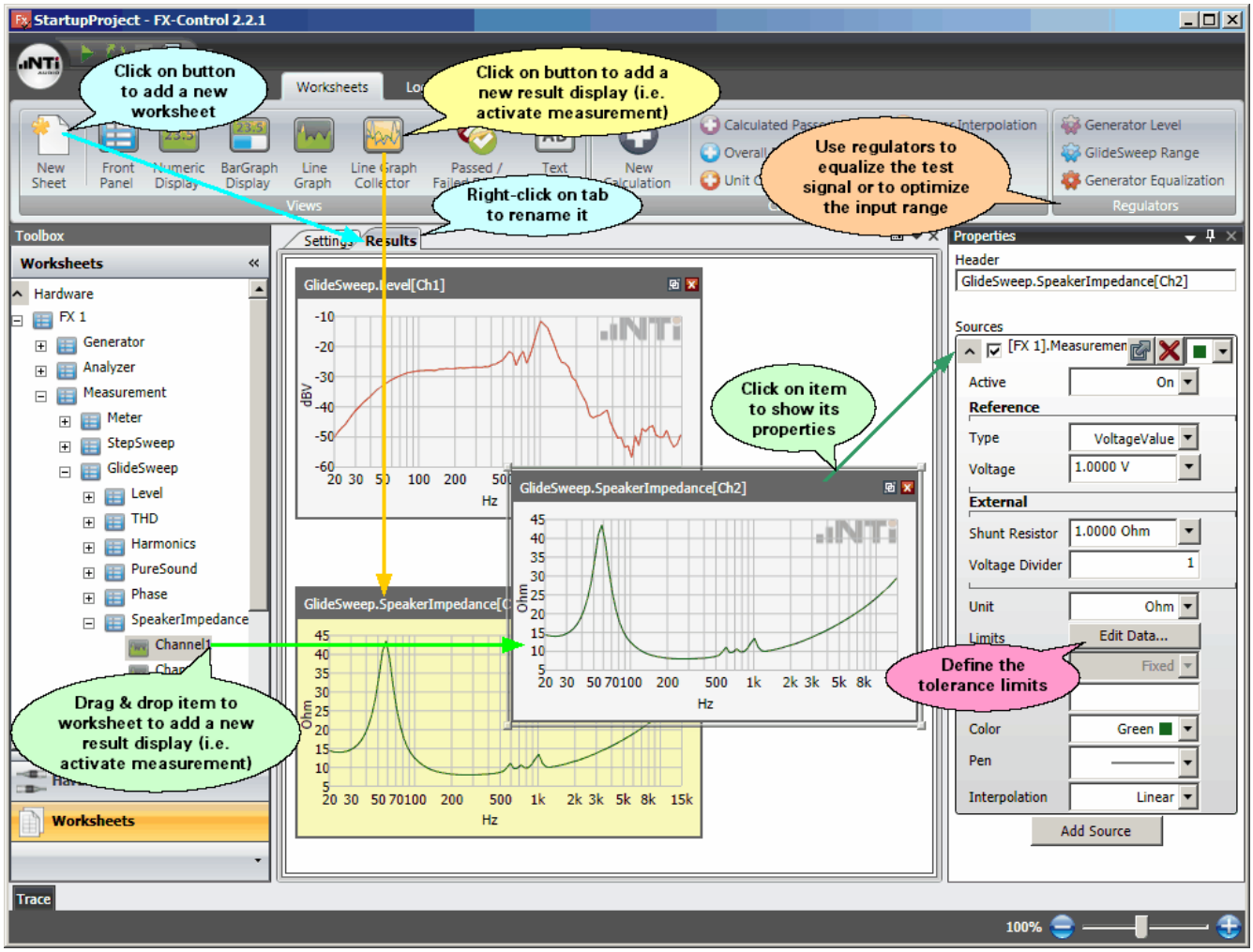
Step 3 - Activate the measurements

- Optionally add new sheets to the WorkArea, e.g. to host the measurement result displays, and rename them
- Drag & drop a measurement from the toolbox to the WorkArea, or click on a button in the ribbon and select the required measurement
- Use the regulators to adjust or equalize the generated test signal, or to optimize the analyzer input range
- Add a calculation item to calculate special results out of the acquired data
- Record reference data and define the tolerance limits


StartupProject - FX-Control 2.2.1
Click on button to add a new worksheet
Click on button to add a new result display (i.e. activate measurement)
Use regulators to equalize the test signal or to optimize the input range
Right-click on tab to rename it
Click on item to show its properties
Drag & drop item to worksheet to add a new result display (i.e. activate measurement)
Define the tolerance limits
Worksheets
Views
Regulators
Toolbox
Properties
Results
Trace
Add Source

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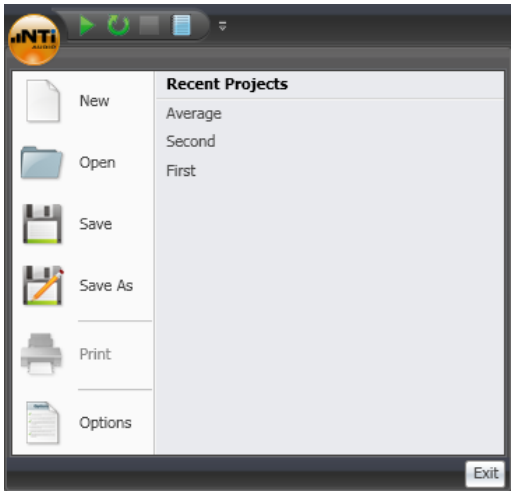
3.2 Project handling

The term 'project' is used for a file that contains all relevant information of a specific test setup, i.e.

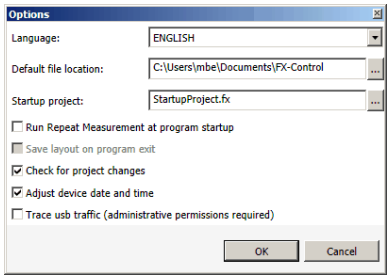
- Hardware & Wiring status (e.g. hardware components, routing)
- Worksheet panels and settings (e.g. generator / analyzer parameters, active measurements, tolerance limits, calculation items, regulators)
- Data logging status

NOTE **A project contains the exact hardware status information of the connected FX100 Device (i.e. the installed boards) and the wiring. Therefore, if an existing project is applied on a FX100 Device that has a different hardware status, only a restricted number of project settings may become effective.**

Click on the application button to save or load a project (use the Windows Explorer to rename, organize or delete your projects).



- New → creates a new project (all current items of the WorkArea are cleared)
- Open → opens a previously saved *.FX project.
  Alternative: select the requested project directly from the "Recent Projects" list
- Save → saves the current settings as *.FX project
- Save as → saves the current *.FX project under a different name
- Print → prints out the contents of the WorkArea (refer also to chapter 'View' ribbon)
- Options→ opens the "Options" pop-up (see below)
- Recent Projects → list of saved projects (Note: compatibility is only checked when the project is opened)
- Exit → shuts down FX-Control



- Language → select the preferred language of the FX-Control menus & labels
- Default Project Location → root directory for FX-Control projects
- Startup Default Project→ the corresponding project is opened automatically after startup
- Run Repeat Measurement at program startup → if this checkbox is ticked, the Startup project is automatically loaded & executed in repeat mode after running FX-Control
- Save layout on program exit → tick this checkbox to restart FX-Control with the current layout
- Check for project changes → clear this checkbox if the system shall not ask you to save any changes when you load another project
- Adjust Date & Time → tick this checkbox to automatically synchronize the internal FX100 clock with the PC
- Trace usb traffic → tick this checkbox to save a trace of the USB communication between the PC and FX100 in a file

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Open a new, existing project / Exit, save a project

Following general rules apply when you start FX-Control, open a new or an existing project, or when you exit or save an open project.

i. Start FX-Control → FX-Control copies all current settings of the connected FX100

ii. New Project → FX-Control clears all items from the WorkArea, and resets all FX100 settings to the default values

iii. Open Project → FX-Control loads the WorkArea status and the FX100 settings from the project file

iv. Exit Project → FX-Control prompts the user to confirm, whether the current project status shall be saved, or not? (Hint: this interaction can be disabled, see above)

v. Save Project → FX-Control saves the current project status under the current name

vi. Save Project As → FX-Control saves the current project status under a new, custom-defined name

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3.3 Quick access toolbar

The Quick access toolbar provides a direct access to preferred buttons and features. It can be customized as follows to meet your individual needs:

- Left-click on the arrow on the right-hand side to open the pull-down menu. Then select the required feature.
- Right-click on any button in the ribbon and select "Add to Quick Access Toolbar".
- Right-click on any button in the Quick access toolbar and select "Remove from Quick Access Toolbar"

Example of customized Quick access toolbar

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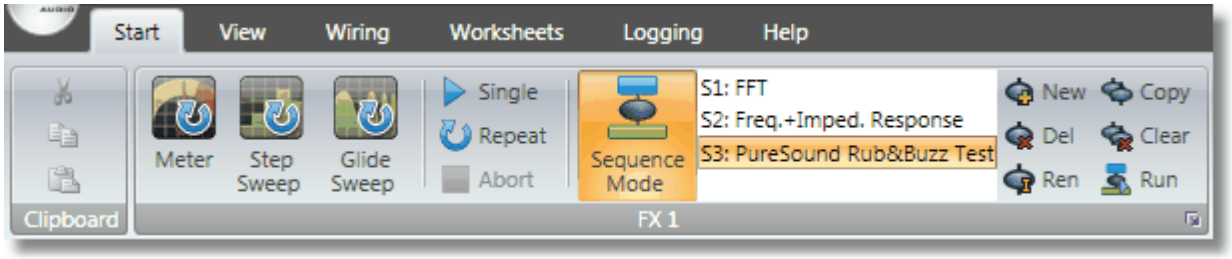
3.4 'Start' ribbon

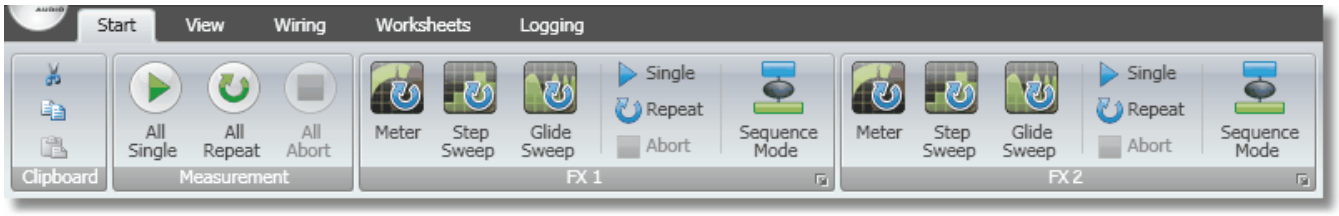
The Start ribbon comprises of three sections; Clipboard, Measurement and FX 1.

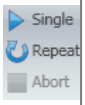
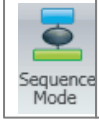
If a second or more FX100 Devices are connected to the controller PC, an additional section FX 2 etc. will be added for each instrument.

Single FX100



Two or more FX100 Devices connected to the same controller PC



Button	*Description*
	Clipboard • Cuts the selected item from the Hardware & Wiring view or WorkArea • Copies the selected item from the Hardware & Wiring view or WorkArea • Pastes the selected item to the Hardware & Wiring view or WorkArea
	Initiates a continuous Meter measurement
	Initiates a continuous StepSweep measurement
	Initiates a continuous GlideSweep measurement
	Initiates the consecutive execution of all active measurements on the corresponding FX100 Device • Single shot (refers only to the selected sequence state) • Repeat • Abort
	Opens the Sequence mode, i.e. sequential execution of a number of user-defined measurements

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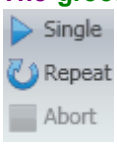
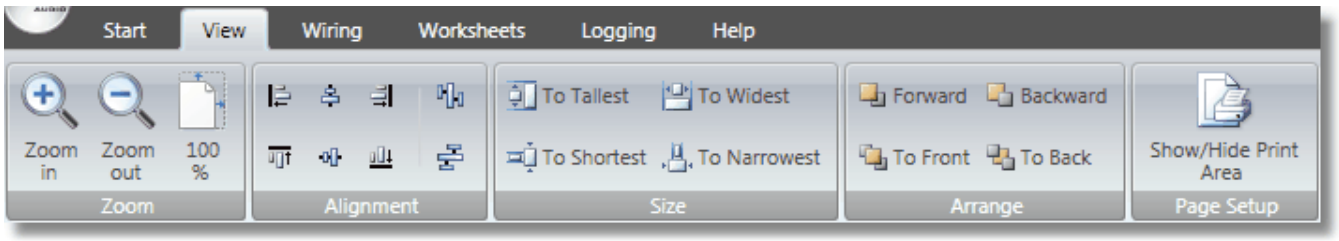
	Initiates the consecutive single-shot execution of all active measurements (and of the complete sequence) on all connected FX100 Devices
	Initiates the repeated consecutive execution of all active measurements on all connected FX100 Devices
	Stops the current ongoing measurement(s)

NOTE The green **and** **buttons apply on all connected FX100 Devices, whereas the blue**  **buttons refer to the corresponding FX100 Device only.**

3.5 'View' ribbon

The buttons in the View ribbon are used to adjust the size, alignment and arrangement of the elements in the WorkArea.



- Zoom: enlarge or scale down the items in the WorkArea (same effect as Zoom slider).
- Alignment and Size: select the panel(s) that require alignment or sizing, then click on the appropriate button.
- Arrange: arrange the screen depth position of the selected panel in relation to each other.
- Page Setup: click on the button "Show/Hide print Area" to show the area(s) of the WorkArea that will be printed (e.g. via <Ctrl> + <P>)

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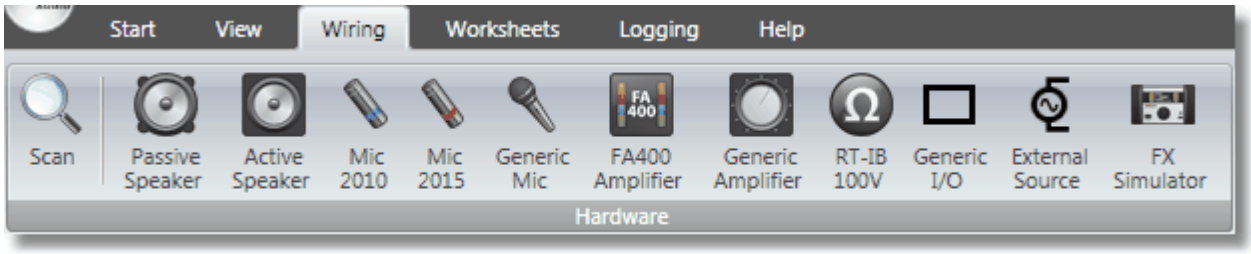
3.6 'Wiring' ribbon

The Wiring ribbon offers a number of standard items for use in the Hardware & Wiring view.



Hint ***All buttons in the Wiring ribbon can be found also via right-click in the WorkArea when the Hardware & Wiring view is active***

Button	*Description*
Scan	Executes a scan to detect all FX100 Devices or other devices that are connected to the controller PC
Speaker	Adds a passive loudspeaker item to the Hardware & Wiring view
Active Speaker	Adds an active loudspeaker item to the Hardware & Wiring view
Mic 2010	Adds an M2010 measurement microphone item to the Hardware & Wiring view
Mic 2015	Adds an M2015 measurement microphone item to the Hardware & Wiring view
Generic Mic	Adds a generic microphone item to the Hardware & Wiring view
FA400 Amplifier	Adds an FA400 amplifier item to the Hardware & Wiring view
Generic Amplifier	Adds a generic amplifier item to the Hardware & Wiring view
RT-IB 100V	Adds an RT-IB external impedance box item to the Hardware & Wiring view

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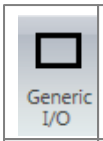
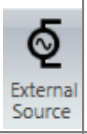
	Adds a generic item, with an analog input & output, to the Hardware & Wiring view (e.g. representing an equalizer, mixing console channel or other electronic circuit)
	Adds an external signal source item to the Hardware & Wiring view
	Adds an FX100 simulator item to the Hardware & Wiring view (e.g. for demo mode) **NOTE Projects that have been established with an FX100 simulator can not be applied on a real FX100 Device**

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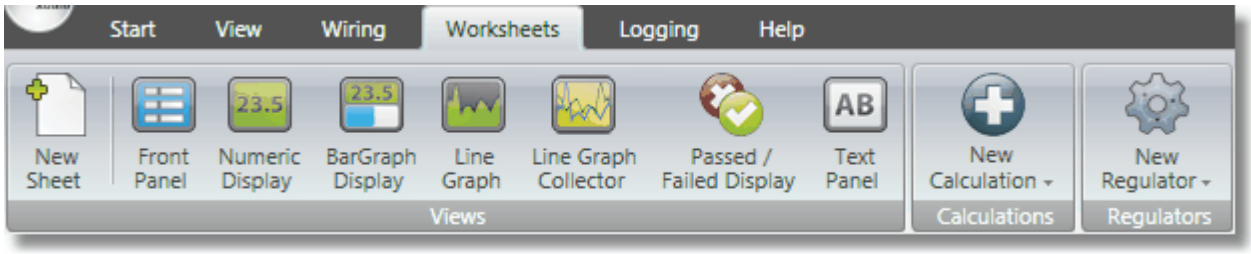
3.7 'Worksheets' ribbon

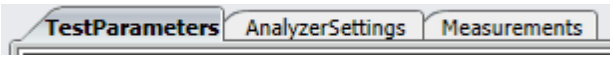
The buttons in the Worksheets ribbon are used to open new test parameter panels, measurement result displays or calculation items.



Hint ***All buttons in the Worksheets ribbon can be found also via right-click in the WorkArea when the Worksheets view is active***

Views

Button	*Description*

New Sheet	Opens a new worksheet (aside from the existing ones). Thus, an overview of complex test setups or comprehensive measurements is possible.
	 
	• Click on the corresponding tab to access the worksheet.
	• Right-click on a tab to
	  ○ rename it
	  ○ close it or close all sheets but this one
	  ○ switch it to floating, dockable or tabbed
	• Place the required items (e.g. generator, analyzer panel or measurement display) on any worksheet ⇒ all items on all sheets are active
	• If a specific item is placed several times on the worksheet(s), then all these items are connected with each other, i.e. if the contents of one item is edited, the connected items will change accordingly.

Front Panel	Adds a new test parameter / settings panel to the active worksheet • Generator → test signal parameters • Analyzer → input settings • Measurement → tolerance limits • Advanced → special settings (e.g. routing or headphone control)
Numeric Display	Adds a Meter measurement display that shows the acquired results numerically.
BarGraph Display	Adds a Meter measurement display that shows the acquired results numerically and in a bargraph.
Line Graph	Adds a Meter, StepSweep or GlideSweep measurement display that shows the acquired result curve(s) and tolerance limits in a graph.

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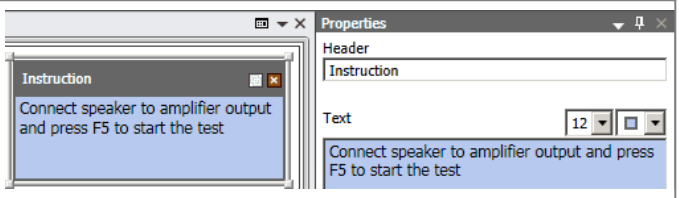
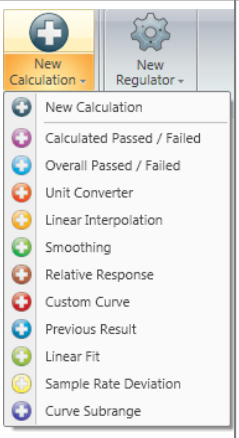
Line Graph Collector	Adds a graphical measurement result display that records all acquired result curves, for example • all recorded FFT spectra • all recorded StepSweep or GlideSweep curves
Passed / Failed Display	Adds a display that shows the PASSED / FAILED result of the related measurement **NOTE The measurement must have tolerance limits set in order to implement a PASSED / FAILED rating**
AB Text Panel	Adds a text panel to the active Worksheet with editable • header • contents (memo) • font size • background color



Calculation Items

Hint Please refer also to the detailed description of the Calculation Items

Button	*Description*
	• Upper section: adds a new generic calculation item. • Lower section: provides access to the default calculation items ○ Calculated Passed / Failed: checks the output of another calculation item against the user-defined Pass/Fail limits ○ Overall Passed Failed: combines the individual Passed/Failed results of several calculation items ○ Unit Converter: shows the active measurement with a different unit of measurement (e.g. V instead of dBV) ○ Linear Interpolation: calculates the interpolated result at a user-defined frequency (x-value) of a measured curve ○ Smoothing: smooths the acquired curve by averaging the measurement results within a window of user-defined width ○ Relative Response: plots the acquired result curve relative in dB to the Y-value of a reference point at an user-defined X-value ○ Custom Curve: creates a user-defined curve (e.g. to be used as tolerance limit or calculation data) ○ Previous Result: shows the previous acquired result ○ Linear Fit: calculates a straight line that represents the optimum linear fit to the measured curve ○ Sample Rate Deviation: shows the deviation of the sample rate, i.e. of the Frequency, AES input sample rate, Sync input sample rate vs. the standardized digital sampling frequencies (32 / 44.1 / 48 / 88.2 / 96 / 176.4 / 192 kHz) ○ Curve Subrange: extracts the data of a restricted, user-defined frequency band from within the full range of measured results.

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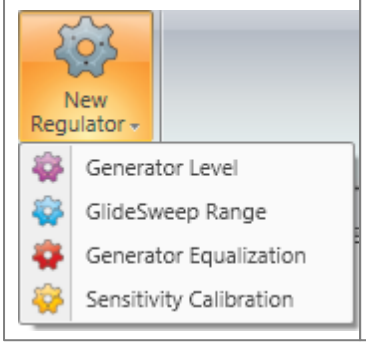
Regulators

Hint ***Please refer also to the detailed description of the Regulators***

Button	*Description*
	The button opens the list of available regulator functions. • Generator Level: adjusts the FX100 output volume so that either the level or THD of the test signal reaches a user-defined value at a specific point in the test setup • GlideSweep Range: evaluates the optimal FX100 input range (i.e. sensitivity) for accurate GlideSweep measurements • Generator Equalization: calibrates the FX100 output signal so that it compensates for the characteristics of the downstream device(s) • Sensitivity Calibration: measures the sensitivity of a connected microphone with the aid of a microphone calibrator

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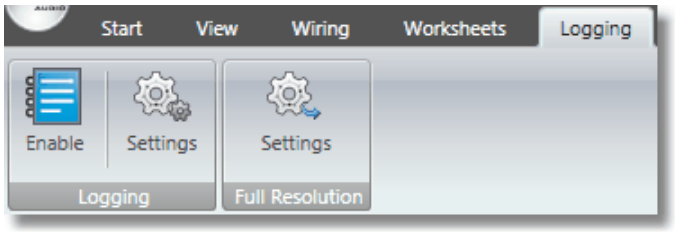
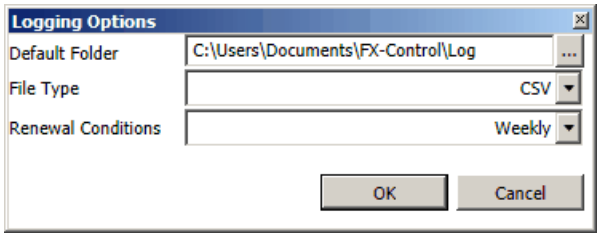
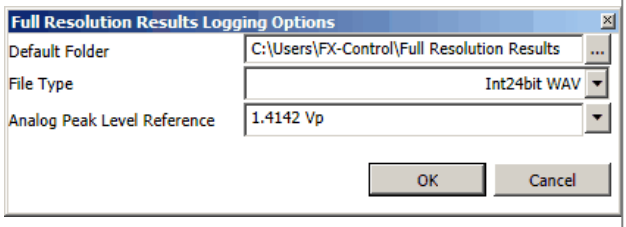
3.8 'Logging' ribbon

This tab is used to enable data logging and adjust the log settings



Button	*Description*	
Enable	Activate the data logging (this button is also located in the Quick access toolbar by default)	
Settings	Adjust the logging parameters i. Default Folder: root directory where the log files are stored. ii. File Type: log file format, e.g. • CSV (comma-separated values) • Text (tabbed text) • XLSX (open office XML) iii. Renewal Conditions: • Never (all acquired results are saved to the same log file) • Weekly (a new log file is created at the beginning of a new week) • Daily (a new log file is created every day) • At Each Measurement (the results of every measurement are saved in an individual log file)	
Settings	Adjust the parameters of the 'Full Resolution' logging mode i. Default Folder: root directory where the log files are stored. ii. File Type: log file format, e.g. • CSV (character-separated values) • Text (tabbed text) • Matlab (*.MAT file format) • Int 24bit WAV (integer WAV file, 24 bit resolution) • Float WAV (floating point WAV file, 32 bit resolution) iii. Analog Peak Level Reference: editable value of the maximum input signal amplitude; corresponds to 100% (applies only for WAV files)	

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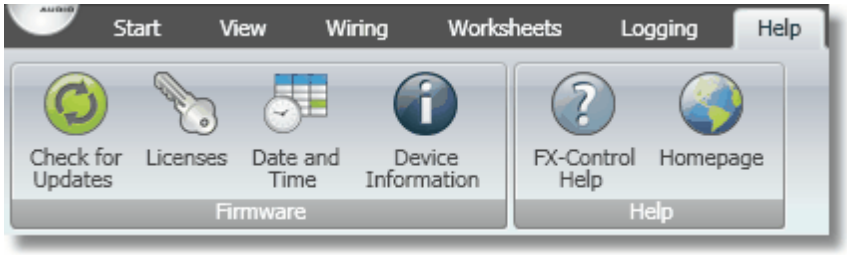
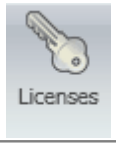
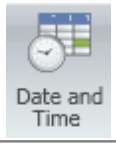
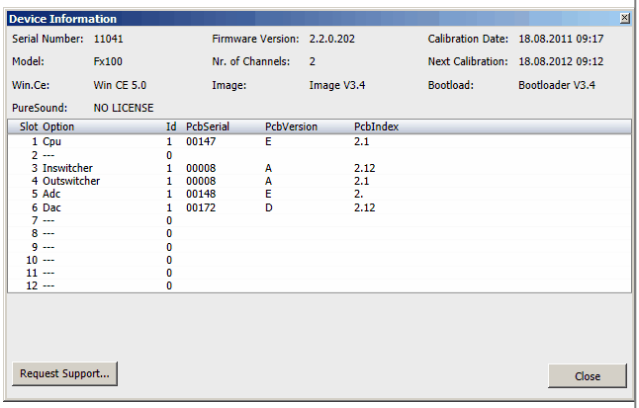
3.9 'Help' ribbon

The Help ribbon provides access to general features and information.



Buttons

Button	*Description*	
	Checks for updates of FX-Control software or FX100 firmware (see below)	
	Shows the licenses that are currently active on the instrument	
	Shows the real-time clock status and allows time and date adjustment	
	Shows the general instrument information • Hardware ○ Serial number ○ Model ○ Number of channels ○ Installed boards & version • DSP firmware ○ Version ○ Licenses installed • CPU firmware ○ Windows CE version ○ Image version ○ Bootloader version • Calibration ○ Date of last calibration ○ Due date of next calibration ***Hint*** ***Click on the button "Request Support..." to open an e-mail to NTi Audio service. Thus, you can e.g. request a (demo) license***	

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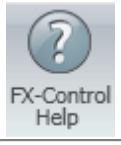
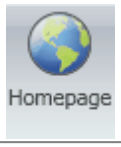
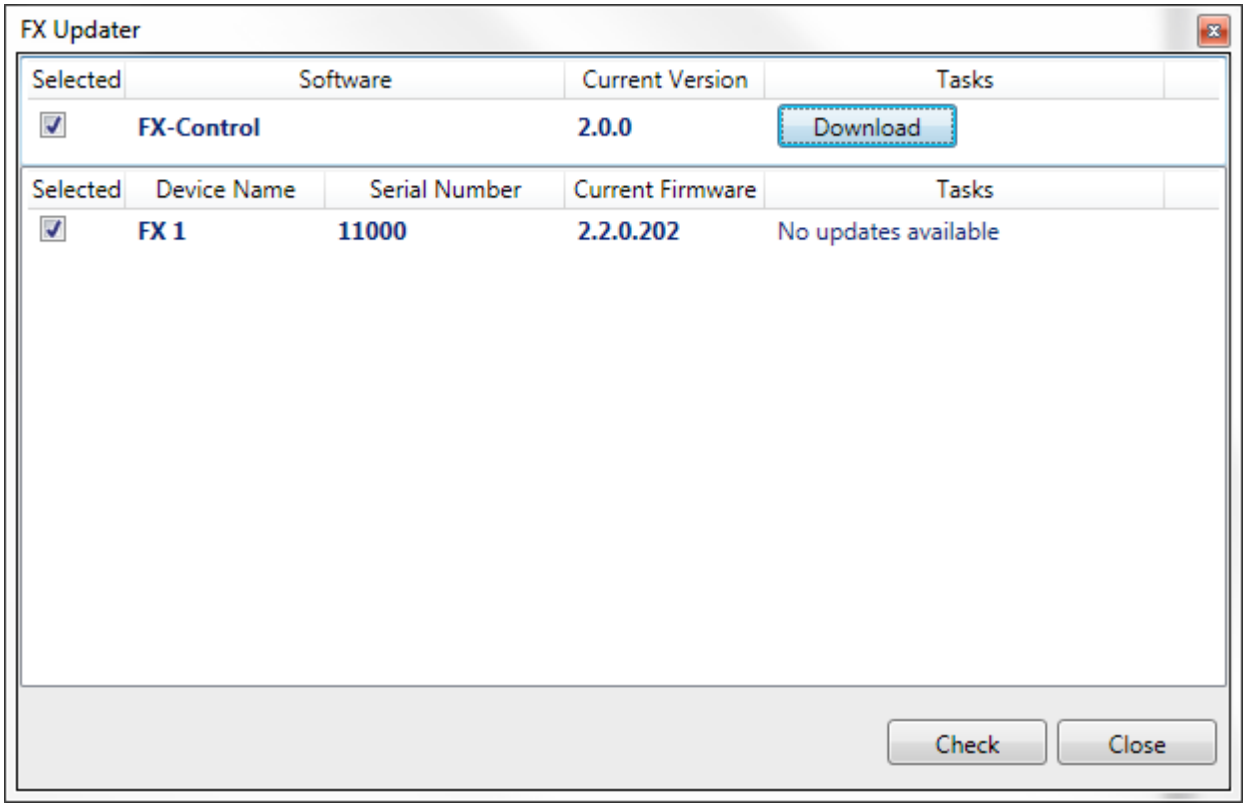
	Opens the FX-Control help file
	Opens a browser and connects to the NTi Audio homepage

PC-Software update

Click on the 'Check for Updates button' in the 'Help' ribbon to check for a new FX-Control software version.

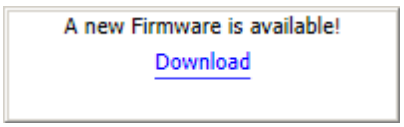


Click on the 'Download' button to install the new version or to store it on your PC.

Firmware update

After startup, the software automatically checks the status of FX-Control as well as the connected FX100 Device (assuming the PC is connected to the internet).

- If a new software or firmware version is available, the user is informed accordingly.



- Click on 'Download' to start the installation process.

Alternatively, you can install a new FX100 firmware at any time as follows.

NOTE Please save your current project before starting the upgrade process.

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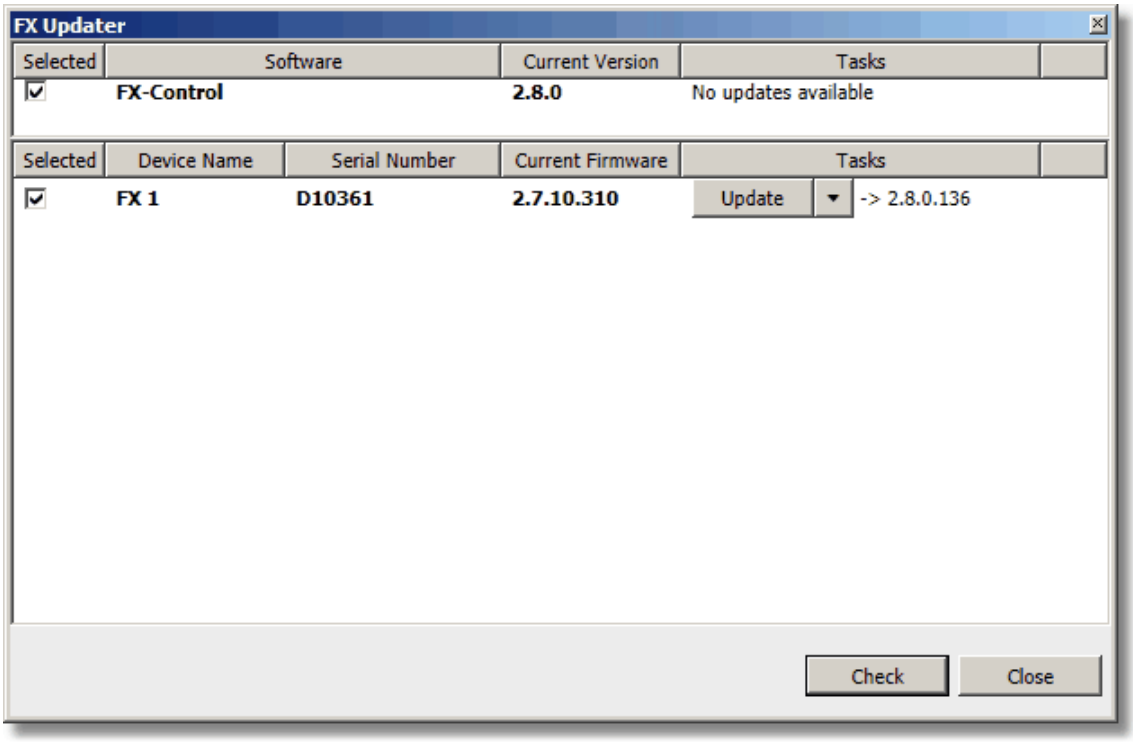
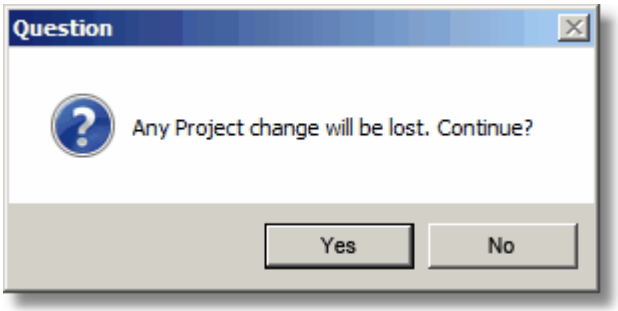
a) Download via FX-Control

- Click on the button 'Check for Updates' in the 'Help' ribbon
- In the 'FX Updater' panel, click on the 'Check' button.



- Click on the button 'Update' (appears only if a new firmware version is available).
- Alternatively, click on the button to download the firmware file to your PC, from where it can be transferred to the FX100 instrument via a USB stick (refer to next chapter).
- Confirm to continue the process in the dialog box.



b) Download via USB-stick

- Save the new firmware file in the root directory of a USB stick.
- Plug the USB-stick into a USB-A connector of the FX100 instrument
- Select the menu 'System' on the LCD by using the rotary encoder
- Move the cursor to '=VER' and press the rotary encoder
- Click on 'FW-UPDATE' to download the firmware to the instrument, or on 'Cancel' to abort.

NOTE The firmware file must match to the serial number of your FX100 Device.

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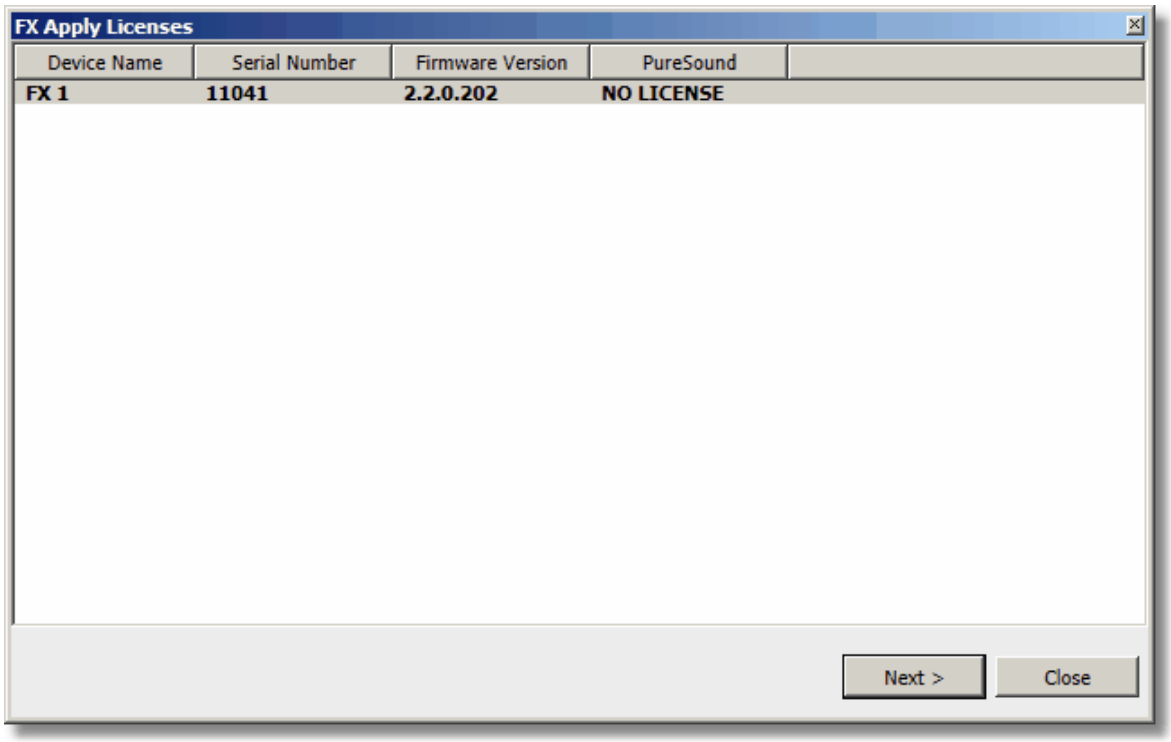
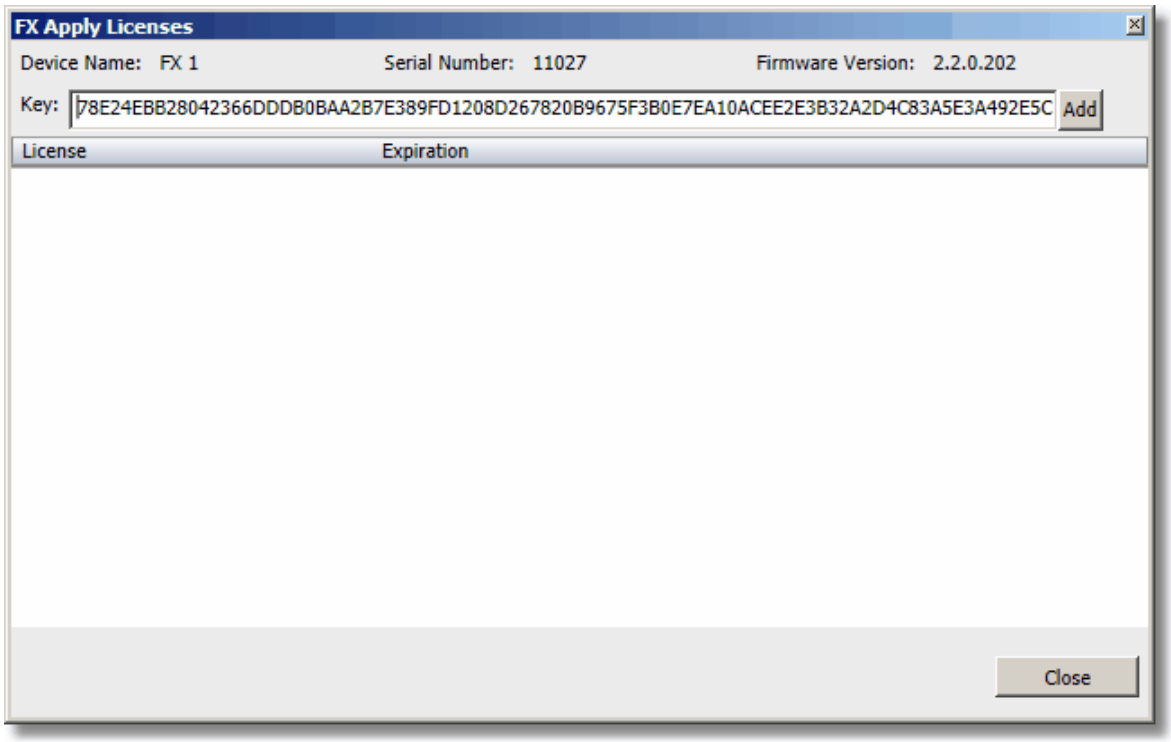
Licenses

Click on the button 'Licenses' to show the active licenses.



To add (i.e. activate) a new license,

- click on the button 'Next',
- enter the license key (as provided by NTi Audio),
- click on the button 'Add'.



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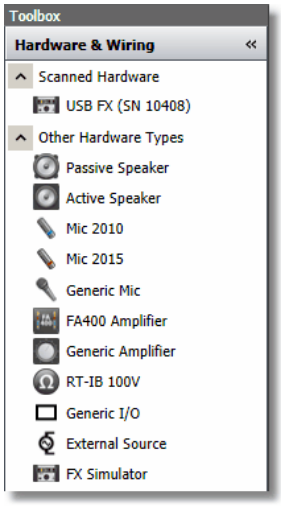
3.10 Toolbox

The toolbox, which is located on the left side of FX-Control, contains either

- the available hardware elements for the wiring, or
- the 'tree' with all control & results panels.

The toolbox allows to switching between the two views Hardware & Wiring – Worksheet

Toolbox 'Hardware & Wiring'

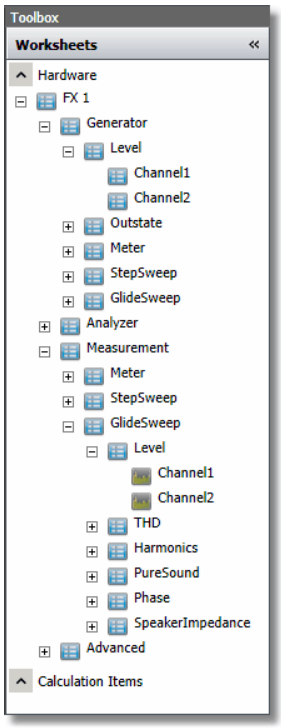


The Hardware & Wiring toolbox shows

- all FX100 Devices that are connected to the controller PC
- additional items that may be part of the test setup (e.g. speaker, microphone etc.)

To specify the wiring, drag & drop the required items to the Hardware & Wiring view and connect them.

Toolbox 'Worksheets'



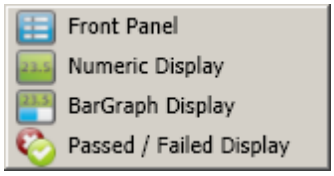
The Worksheets toolbox contains

- the full range of available generator, analyzer, measurement and advanced elements
- the active Calculation items

To set up a test, drag & drop the required control panel or result display to a WorkArea and adjust the corresponding settings. The icon for a

- control panel is **blue**
- numerical or graphical result panel is **green**

Furthermore, by right-clicking on the measurement function, you may activate bargraph or Passed/Failed displays.



The entries below the heading 'Calculation Items' refer to the corresponding items that have been defined by the operator.

Hint ***Calculation items are saved in the project file***

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3.11 Hardware & Wiring

The central area of FX-Control hosts the Hardware & Wiring view, where you can

- establish a virtual 'replica' of the actual test setup,
- access the properties of the employed hardware items.

Click on the

button in the Toolbox to activate the Hardware & Wiring view.

Add remote-controlled device	Click on the 'Scan' button in the Wiring ribbon to show all connected devices that have been recognized by the controller PC.
Add passive device	Drag & drop the required item (e.g. speaker, microphone) from the toolbox to the Hardware & Wiring view *or* Click on the corresponding button in the Ribbon.
Adjust domain of device	Adjust the domain of an installed FX-AES board (Analog or AES) or 'Generic I/O', 'External Source' device (Analog or Digital) via the properties.
Delete device from the view	Right-click on the item and select 'Delete' or press the 'Delete' key on your PC-keyboard.
Arrange items in the view	Left-click and hold on an item , move it to the required place and release the mouse button.
Link connector to item	a) Left-click and hold on the first item in the view, move the cursor to the second item and release the mouse button *Note: only valid connections (e.g. output → input) can be drawn* b) Right-click on the connector and select the required Routing
Mute output connector	Right-click on the generator and select 'Mute On' *or* activate the mute state in the Properties.
Route input connectors	Right-click on an analyzer XLR or BNC connector, or left-click on the small ▾ arrow.
Amend **bias** of input connector	Right-click on the requested input connector and select the requested Bias.
Re-size all items in the view	Use the Zoom slider

NOTE **Some settings in the Hardware & Wiring view are mirrored in the Worksheets, i.e. amending them in either view also has an immediate effect on the other view.**

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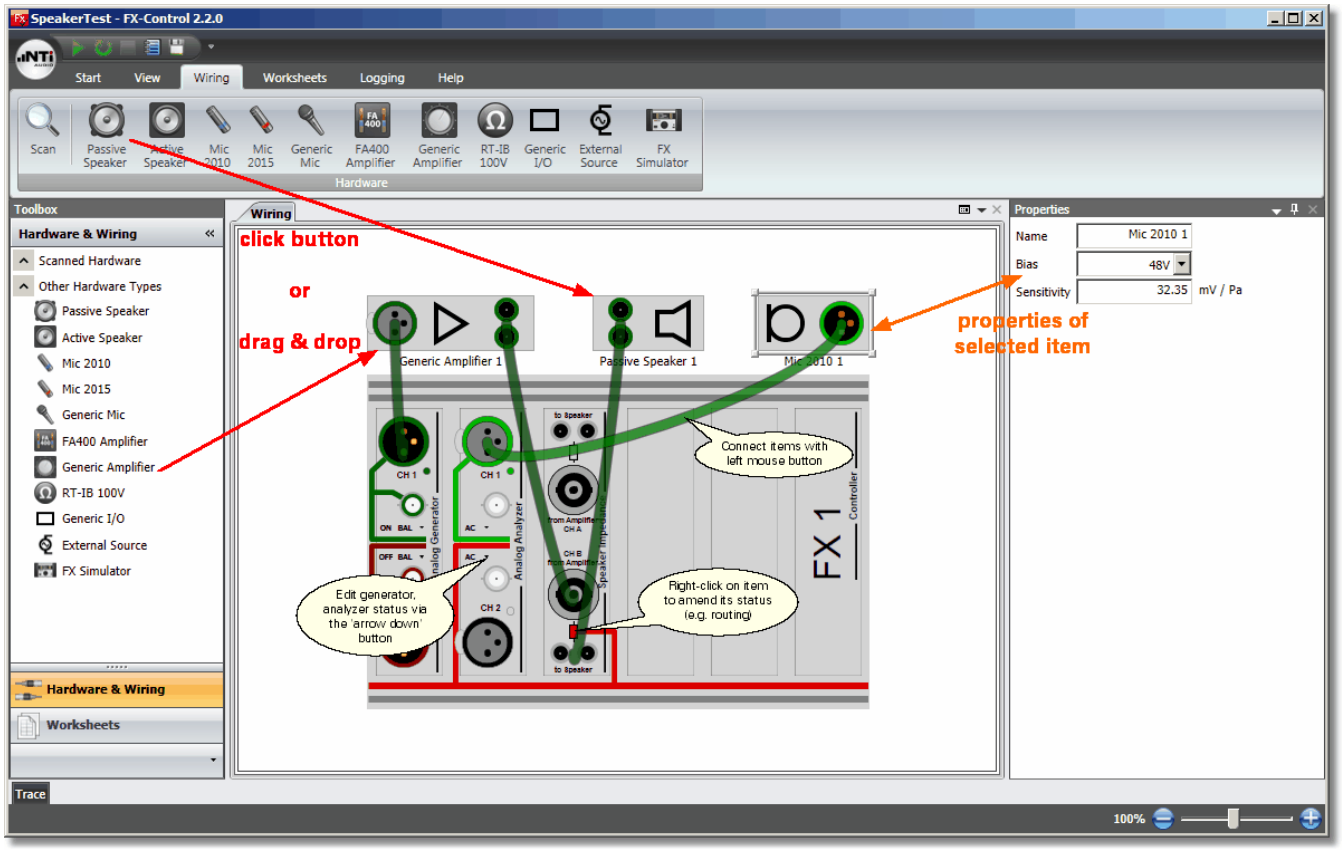
Example 1 – A-A setup

Test setup established by FX100 with FX-SIL option installed, external audio amplifier, passive speaker and M2010 measurement microphone

- FX100 generator CH 1 → linked to Amplifier input
- Amplifier output → linked to SIL input CH B
- SIL output CH B → linked to speaker pins
- SIL shunt resistor → linked to FX100 analyzer CH 2 via Inbus 2
- Microphone → linked to FX100 analyzer CH 1



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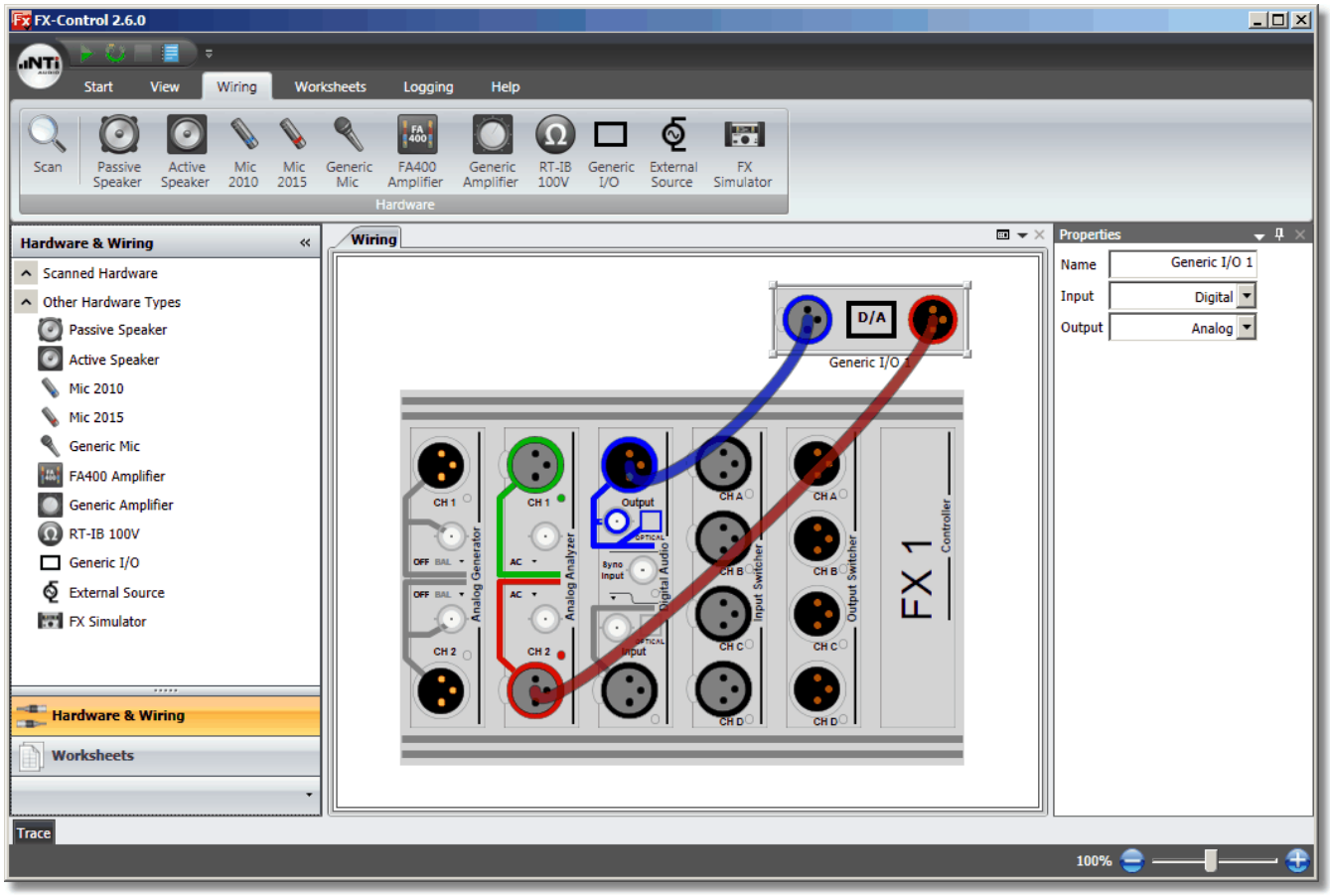
Example 2 – D-A setup

Test setup established by FX100 with FX-AES option installed and generic I/O device (e.g. D/A converter).

- FX100 generator CH 1 → linked via FX-AES board to the DUT
- DUT analog output → linked to FX100 analog analyzer CH 2

Hint ***In case of a digital setup, you have to adjust the properties of the FX100 and of the generic I/O device accordingly.***



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3.12 Worksheets

The WorkArea of FX-Control hosts the Worksheets, where you can

- arrange the required generator & analyzer panels,
- activate measurement functions,
- display the acquired test results.

Click on the

button in the Toolbox to show the Worksheets.

Hint ***The WorkArea may be enlarged by adding another sheet (→ click on the 'New Sheet' button in the 'Worksheets' ribbon)***

Add panel from the Toolbox	Drag & drop the required panel (e.g. Generator Level Channel1) from the toolbox to the WorkArea.
Add panel via the Ribbon	Click on the corresponding button in the 'Results' ribbon and select the required panel.
Delete panel from the view	Click on the button of the corresponding panel.
Move panel	Left-click and hold on the item, move it to the required place and release the mouse button.
Align panel	First click on the root panel, second on the target panel, and then on the corresponding button in the 'View' ribbon to align the target panel.
Re-size panel	a) Click on the panel, then on its frame and adjust its size with the mouse. b) Click on the root panel, then on the target panel, and finally on the corresponding button in the 'View' ribbon to align the target to the root panel.
Re-size all panels in the view	Use the Zoom slider
Arrange panel	Click on the panel and then on the corresponding button in the 'View' ribbon.
Amend **test parameters**	Enter the required values directly in the corresponding panel or via the Properties section

NOTE **Some settings in the Worksheets are mirrored in the Hardware & Wiring view, i.e. amending them in either view also has an immediate effect on the other view.**

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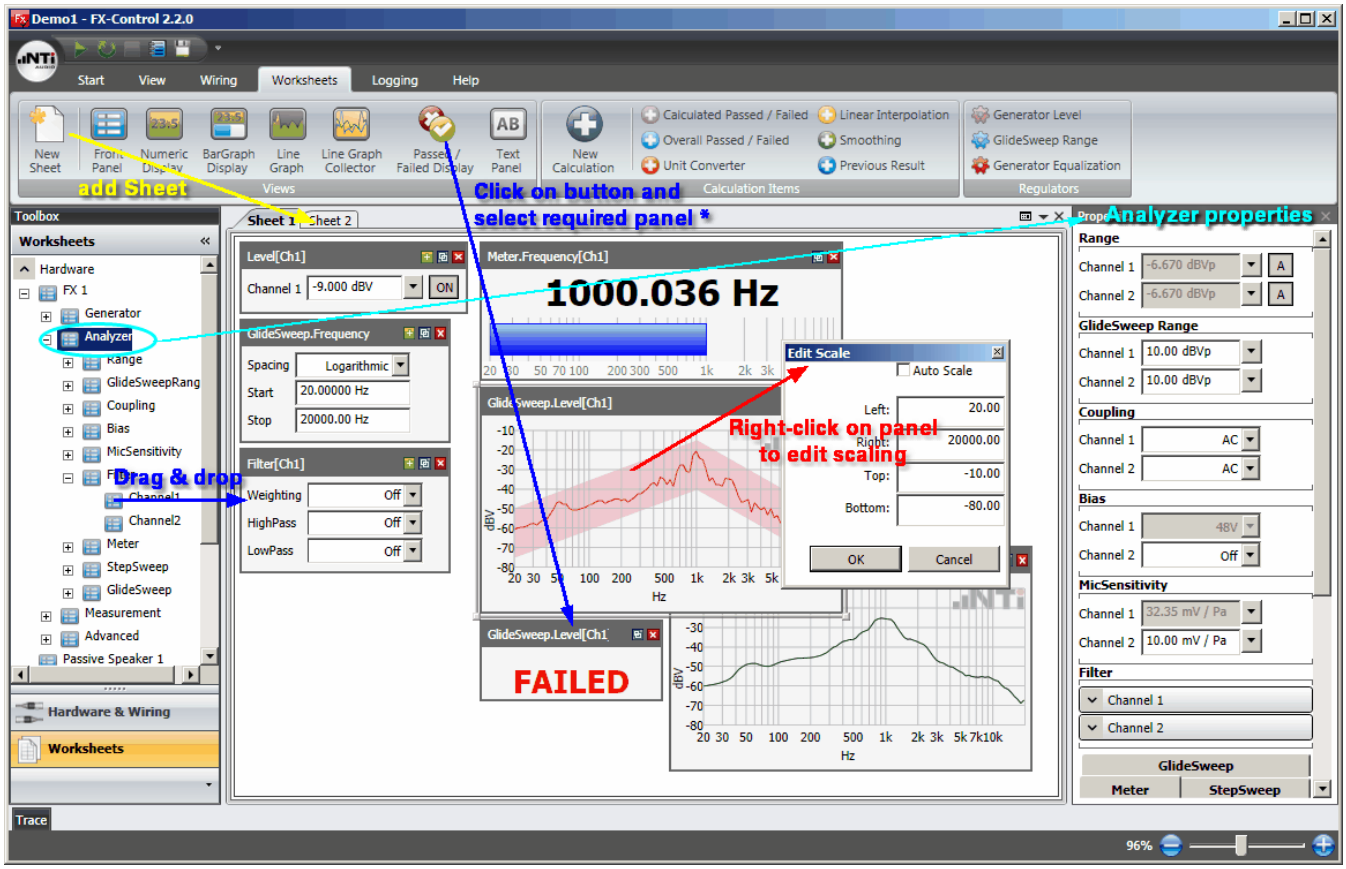
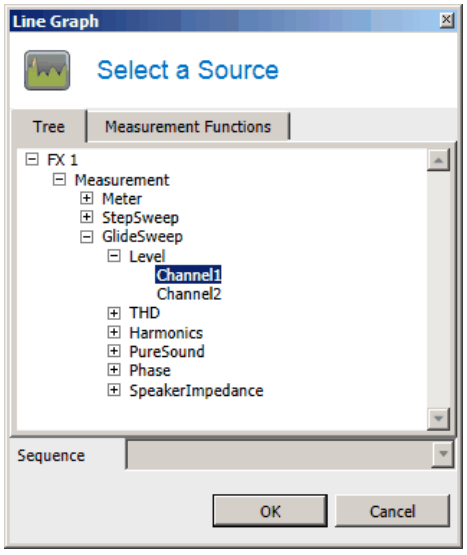
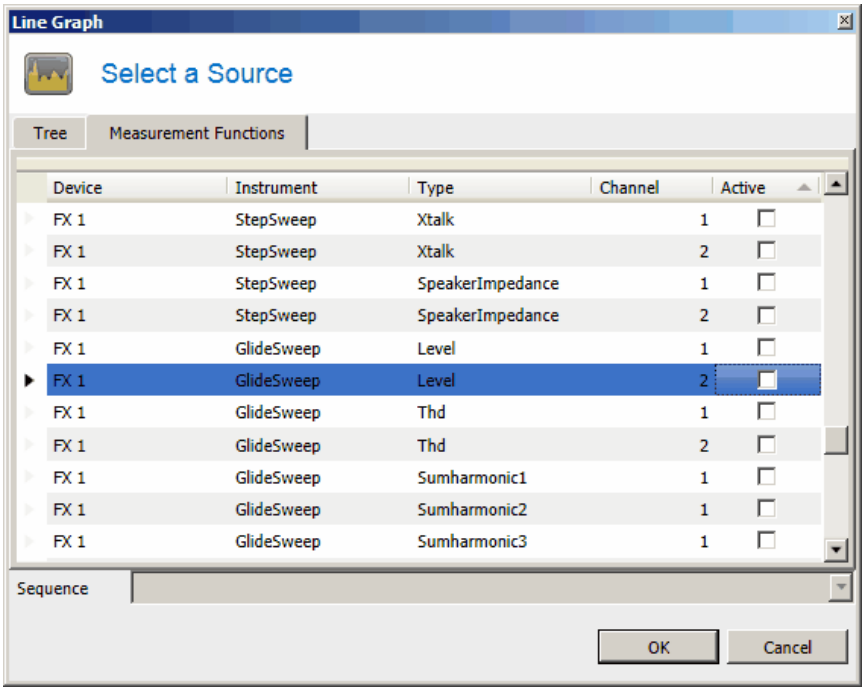
Example



***: select the required panel from the tree, or the list of measurement functions**





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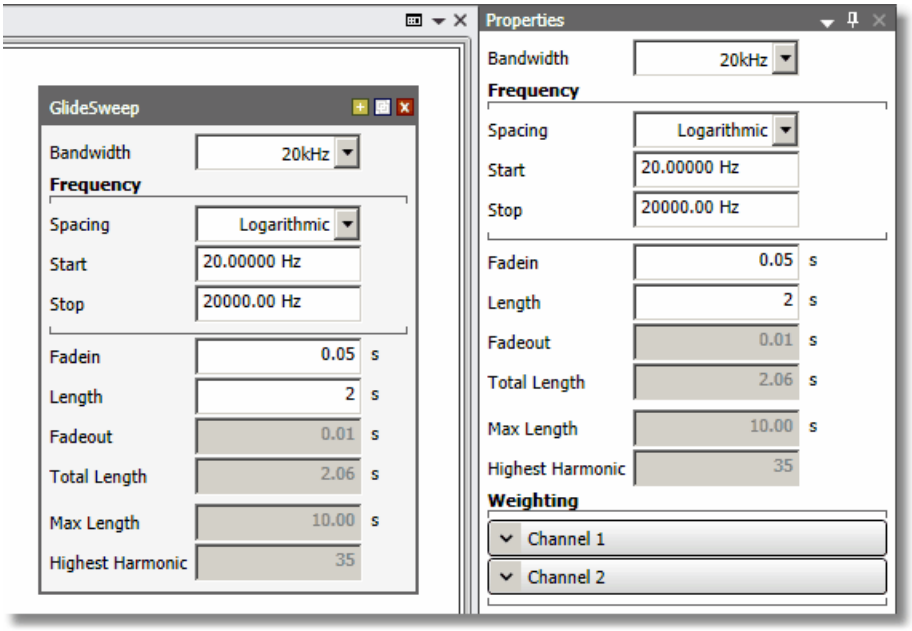
3.13 Properties

All items and panels in the Toolbox, the Hardware view or a Worksheet have individual properties, i.e. adjustable parameters.

Click on any item in a Toolbox or the WorkArea to show these properties and get access to the editable parameters.

Example 1



Generator GlideSweep panel and properties

Hints ***Click on the button in the panel, or on in the properties section to show all available properties.***

The properties section is directly linked to the related panel, i.e. amending a parameter in either place is amended immediately in the other.

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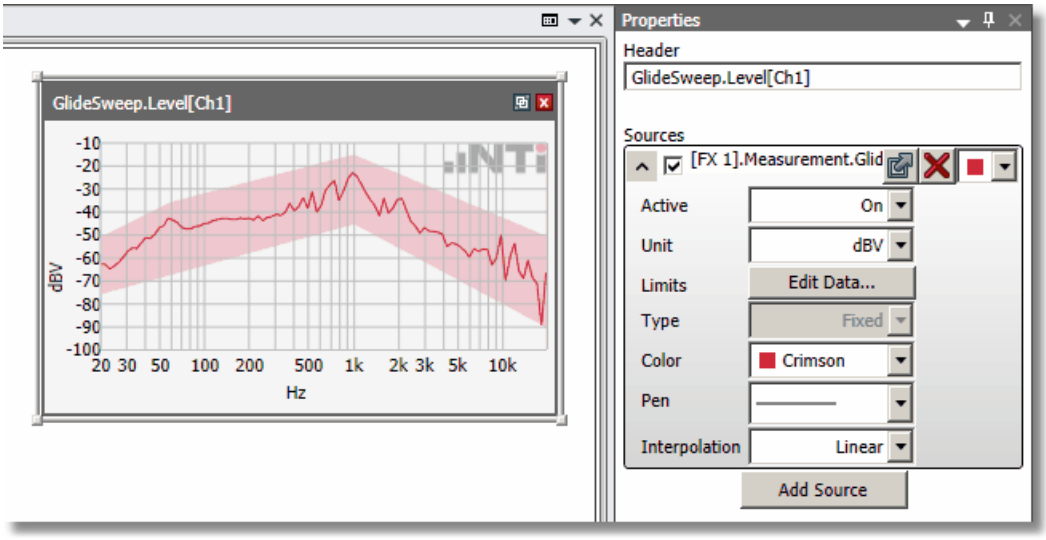
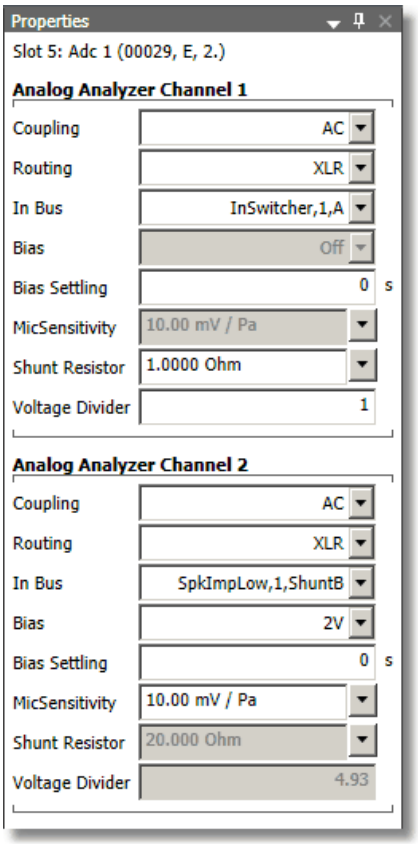
Example 2



GlideSweep frequency response graph and properties

Example 3



Properties of the analyzer board

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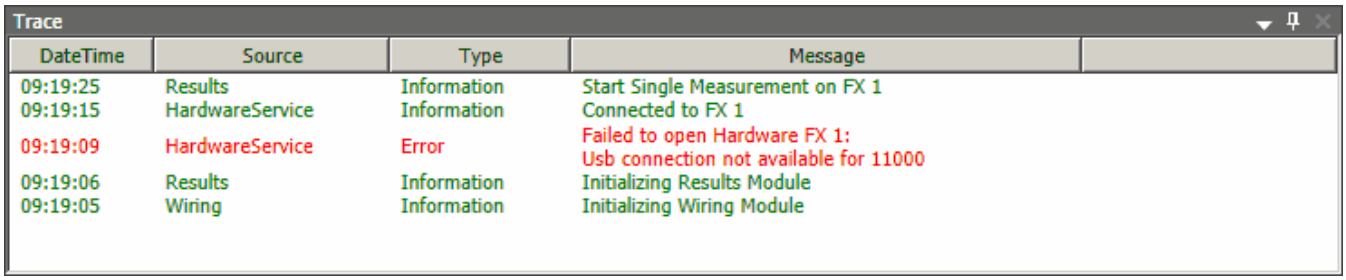
3.14 Trace


Trace
DateTime
Source
Type
Message
09:19:25 Results Information Start Single Measurement on FX 1
09:19:15 HardwareService Information Connected to FX 1
09:19:09 HardwareService Error Failed to open Hardware FX 1:
Usb connection not available for 11000
09:19:06 Results Information Initializing Results Module
09:19:05 Wiring Information Initializing Wiring Module

The trace in the lower section of the FX-Control window shows

- the full communication between the controller PC and the FX100 Device
- Warnings and error messages

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Part IV

4 Generator settings

FX100 can be used to generate Meter, StepSweep or GlideSweep test signals.

To get access to the editable properties of the available output channels,

- drag & drop the required generator panel(s) to the WorkArea, or
- use the generator properties

Numerical values (e.g. level, frequency)

Click on an input box and adjust the value as follows.

- Exact value: enter the required value directly via the keyboard (e.g. "0.514" or "8k" etc.)
- Stepwise: use the up, down arrow keys or the scroll wheel of your mouse

Measurement Units (e.g. Vp, dBu, dBV)

There are two ways to select the level unit of measurement.

a) Click on the button and select the required unit
b) Enter the unit directly together with the level (e.g. "320mV" or "-12.5 dBV" etc.)

Connector status (e.g. Mute On/Off, waveform)

Activate or select the required state by clicking on the related

- On/Off button (e.g. output channel 1)
- button (e.g. channel OutState, StepSweep signal source, frequency spacing etc.)

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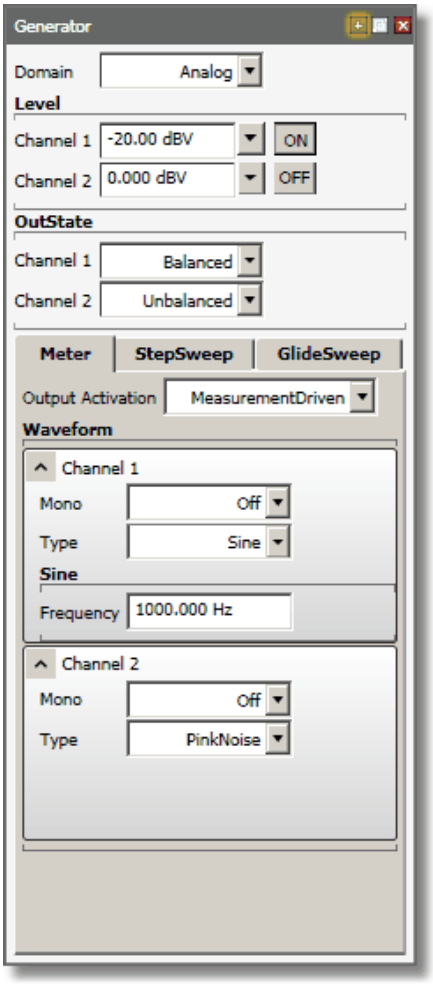
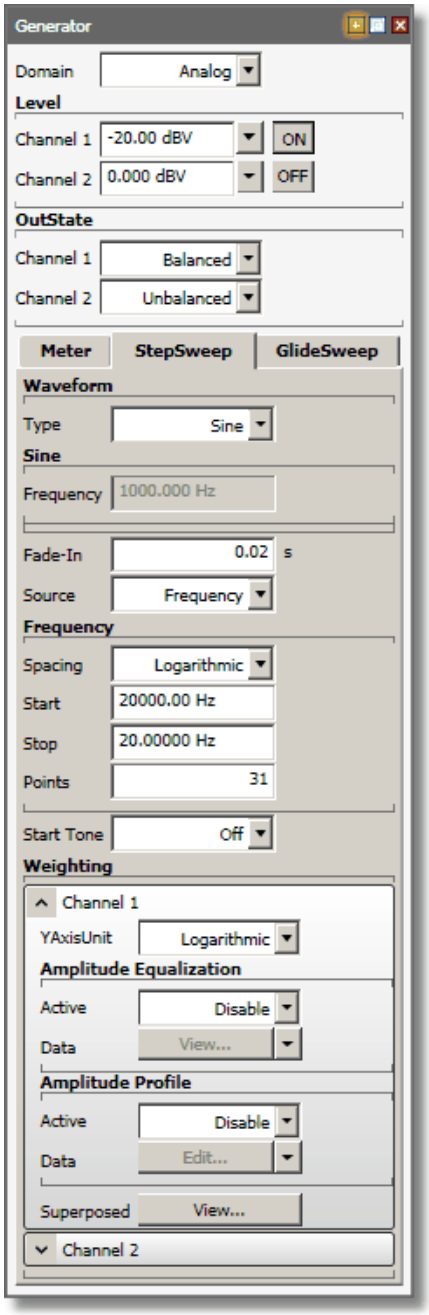
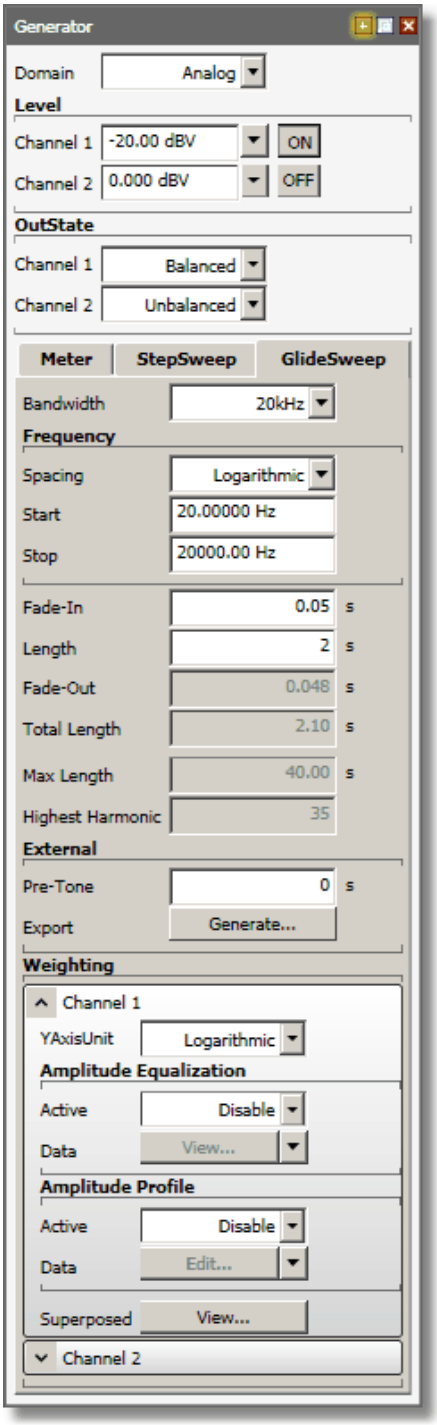
Meter



StepSweep



GlideSweep



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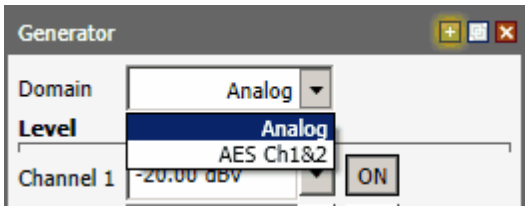
4.1 Domain

Hint ***The property "Domain" is only available if the FX-AES board is installed.***

If the generator is switched to digital domain, the domain-specific properties will be displayed in blue color.



The FX100 generator can be switched to analog or digital domain via the properties in the

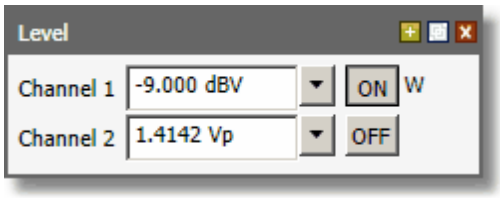
- Hardware & Wiring or
- Worksheets view.

NOTE **The generator level and the tolerance limits are handled independently in the analog, digital domain. If you amend e.g. the digital output level, the previously adjusted analog level will not be changed.**

4.2 Level

The generator level can be adjusted individually on each output channel.

Level & Measurement Unit



The supported level ranges are

- 0.001...12.430 V
- 0.0014...17.58 Vp
- –60.00...21.89 dBV
- –57.00 ...24.90 dBVp
- –57.78 ...24.11 dBu
- –54.77...27312 dBup

NOTE **Discrepancies between the entered level and the displayed value are due to rounding effects. In case of a PinkNoise or WhiteNoise output signal, please obey the corresponding Crest factors.**

Channel On/Off

Click the ON/OFF button to activate or deactivate (i.e. mute) the corresponding output channel.

The default state of generator output channels is OFF

W (weighting active)

If a sweep weighting is active for an output channel, the character "W" appears in the generator level panel.

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4.3 Outstate

The generator XLR, BNC output connectors are permanently linked together.

- Pin 2 of the XLR is connected to the center pin of the BNC
- Pin 3 of the XLR is linked to the BNC shield

Balanced

Standard operating mode for typical Audio circuits.

If XLR pin 2 or 3 are shorted to GND, the FX100 generator will be switched off automatically

Unbalanced

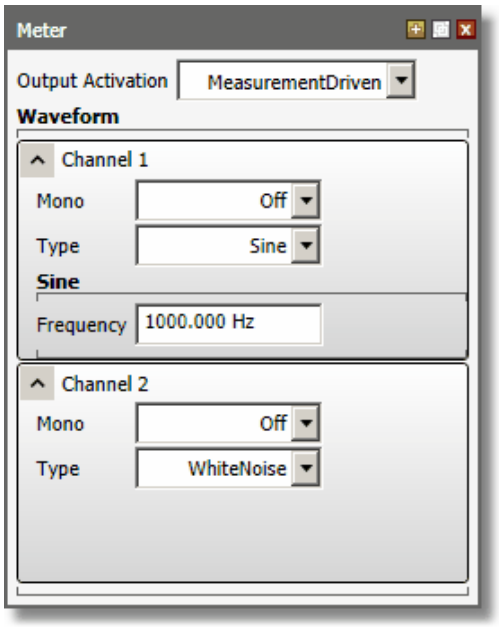
The FX100 generator must be switched to unbalanced mode, if XLR pin 3 or BNC shield is shorted to GND.

The maximum FX100 output voltage in unbalanced mode is +15.9 dBV

NOTE The generator output is switched OFF automatically if XLR pin 2 or BNC pin 1 are shorted to GND.

4.4 Meter

The following generator settings can be adjusted in the Meter mode.



- Output Activation → defines when the test signal is generated
  - AlwaysOn → FX100 continuously generates the active signal, regardless whether a measurement is ongoing or not
  - MeasurementDriven → FX100 only generates the active signal as long as a measurement is going on
- Waveform Mono
  - On → both output channels of a FX100 generator module (1&2 or 3&4) generate the same signal
  - Off → every output channel can generate a different signal (e.g. CH1 with Sine 1 kHz / CH 2 with Sine 3,15 kHz or CH1 with WhiteNoise / CH 2 with Sine 2 kHz)
- Waveform Type
  - Sine wave
  - WhiteNoise [1)]
  - PinkNoise [2)]
- Sine Frequency (applies only for Sine signal)

[1)]: The WhiteNoise has a Crest factor of **3.646** ⇒ if the Generator output level is adjusted to 0 dBV = 3.01 dBVp, the WhiteNoise RMS level = –8.226 dBV

[2)]: The PinkNoise has a Crest factor of **3.846** ⇒ if the Generator output level is adjusted to 0 dBV = 3.01 dBVp, the PinkNoise RMS level = –8.710 dBV

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4.5 StepSweep

FX100 supports four different StepSweep modes.

a) Frequency → the frequency of the generated test signal changes according to the user settings, while the signal amplitude remains fixed

b) Amplitude → the level of the generated sine wave changes according to the user settings, while the signal frequency remains fixed

c) Time → the measurements are acquired over a user-defined time period

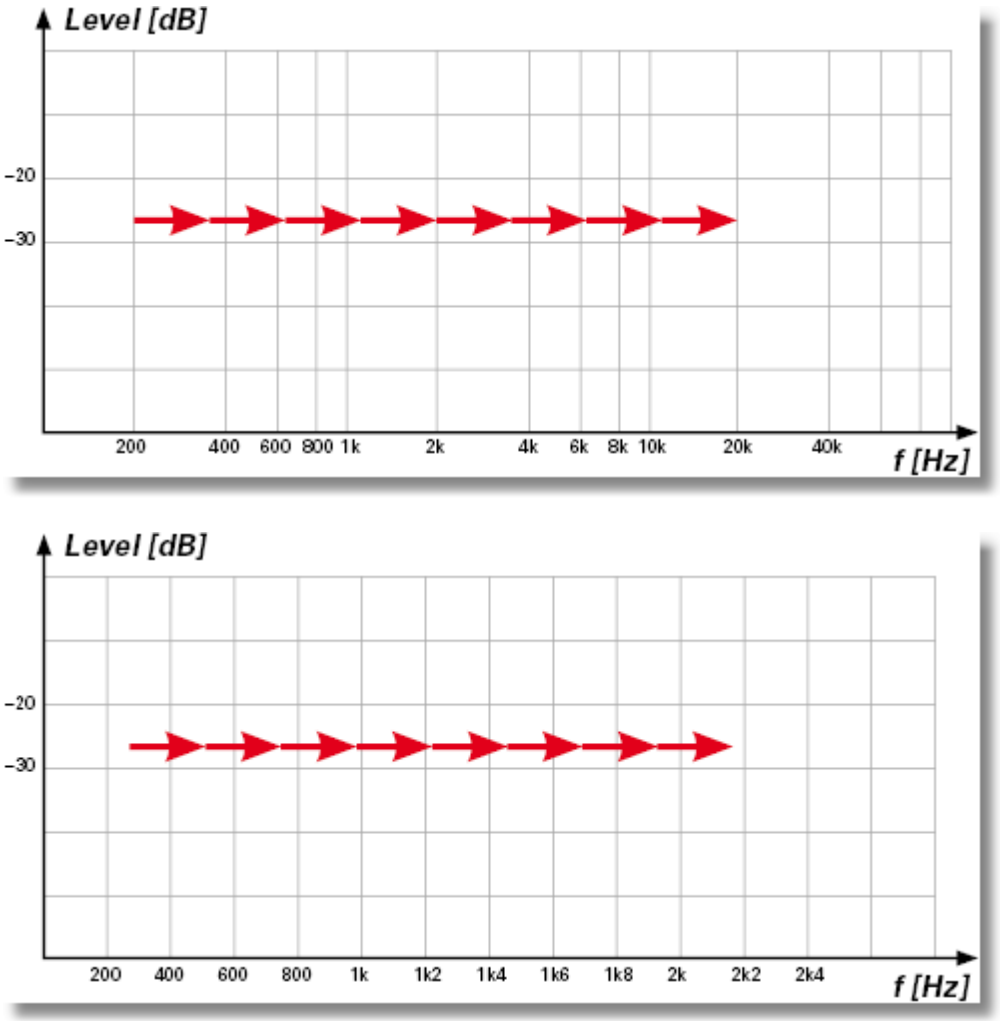
d) Table → a sequence of isolated test signals with individual levels & frequencies is generated according to the user settings

NOTE **Some sweep parameters are only accessible via the Generator properties, if the analyzer synchronization source is switched to 'Generator'.**
Otherwise, for example in case of an external sweep analysis, these parameters must be defined via the Analyzer properties.

If you switch from one StepSweep mode to another, all tolerance limits of active measurement functions are deleted

Frequency sweep

The frequency of the generated sine signal is swept in equidistant steps over a user-defined frequency range.



Examples of generated logarithmic, linear frequency sweep test signals

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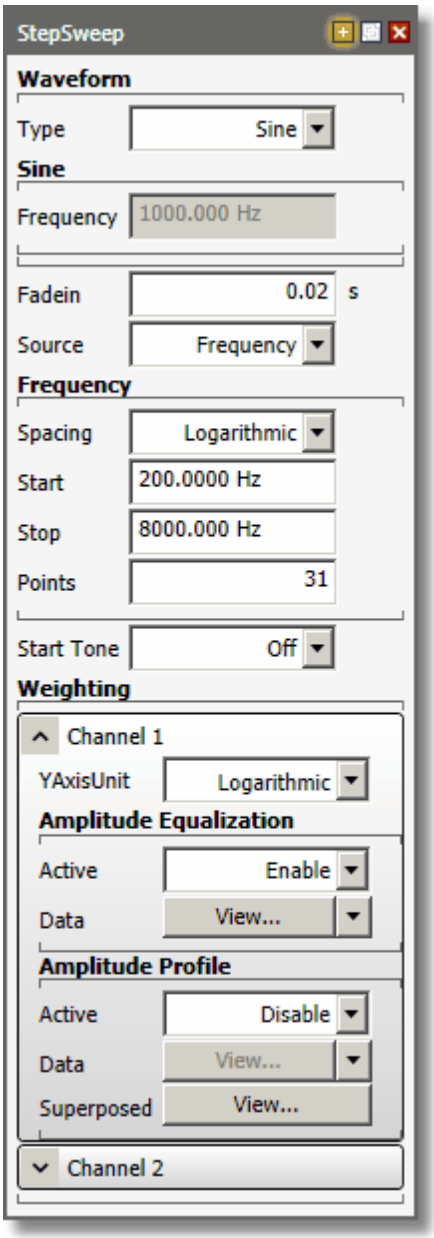

Waveform

- Type → supported StepSweep test signal (i.e.Sine)

Sine

- Fadein → duration of generator fade-in before the sweep starts
- Source → Frequency

Frequency

- Spacing
  - Linear → the generated frequencies are distributed linearly over the X-axis
  - Logarithmic → the generated frequencies are distributed logarithmically over the X-axis
  - R10, R20, R40, R80 → the generated frequencies are distributed according to the ISO-standard over the X-axis
- Start → start frequency of the generated StepSweep (e.g. 20 Hz; Start frequency may be > Stop frequency)
- Stop → end frequency of the generated StepSweep (e.g. 20 kHz; Stop frequency may be > Start frequency)
- Points → number of generated frequencies between the start, stop frequencies
- Start Tone On → a 1 kHz start tone with fixed duration of 1 second is generated prior to the StepSweep execution

Weighting

An individual weighting of the generated frequency sweep signal can be applied to each channel. It is possible, for example, to equalize the generator output, or to apply a user-defined amplitude profile. In either case, the equidistant frequency sweep steps are not affected.

- YAxisUnit
  - Linear → the generated signal level between StepSweep points is interpolated linearly
  - Logarithmic → the generated signal level between StepSweep points is interpolated logarithmically

- **Amplitude equalization**
  - Enable → activates the generator equalization
  - Data View → shows the current values of the generator equalization file
  - Data Copy → copies the contents of the generator equalization file to the clipboard
  - Data Paste → pastes the clipboard contents to the generator equalization file
- **Amplitude profile** (*see below*)
  - Enable → activates the amplitude profile feature
  - Data Edit... → opens a graph with the current amplitude profile
  - Data Copy → copies the numerical values of the current profile to the clipboard
  - Data Paste → pastes the numerical data from the clipboard to the profile
  - Superposed View... → shows current amplitude profile values and curve

Hints ***The frequency sweep analyzer parameters have to be defined via the Analyzer StepSweep properties. The required StepSweep measurements have to be activated separately. If an externally-generated frequency sweep is being analyzed, it is recommended to mute the FX100 output channels***

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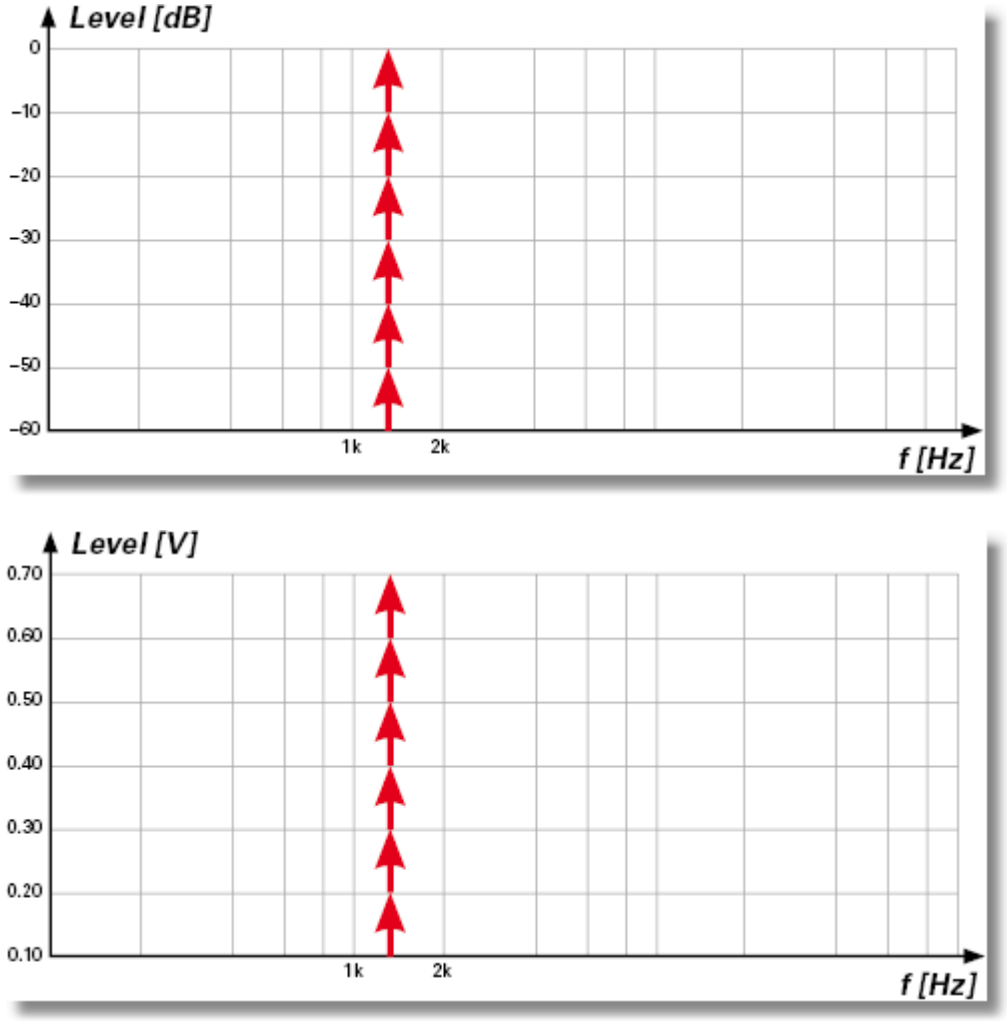
Amplitude sweep

The level of the generated sine signal is swept in equidistant steps over a user-defined level range.



Examples of generated amplitude sweep test signals (linear spacing)

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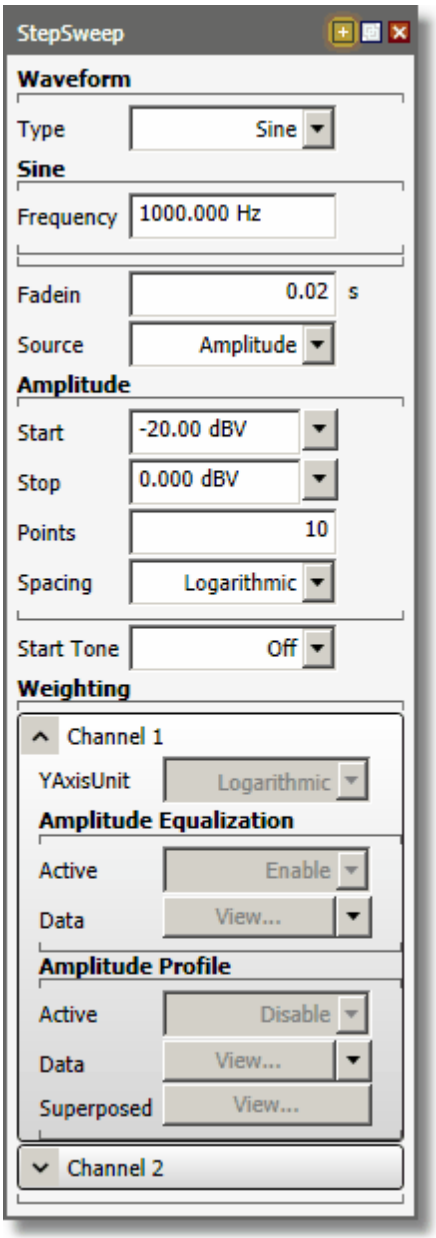

Waveform

Type → supported StepSweep test signal (i.e.Sine)

Sine

- Frequency → the user-defined frequency of the generated sine wave
- Fadein → duration of generator fade-in before the sweep starts
- Source → Amplitude

Amplitude

- Start → start level of the StepSweep (e.g. -20 dBV; Start amplitude may be > Stop amplitude)
- Stop → end level of the StepSweep (e.g. +10 dBV; Stop amplitude may be > Start amplitude)
- Points → number of measurements between the start and stop amplitudes
- Spacing
  - Linear → the generated sweep level steps are distributed linearly (standard application)
  - Logarithmic → the generated sweep level steps are distributed logarithmically (only used if level is expressed in V or Vp)
- Start Tone On → a 1 kHz start tone with fixed duration of 1 second is generated prior to the StepSweep execution

Hints ***The amplitude sweep analyzer parameters have to be defined via the Analyzer StepSweep properties***
The required StepSweep measurements have to be activated separately
If an externally-generated amplitude sweep is being analyzed, it is recommended to mute the FX100 output channels

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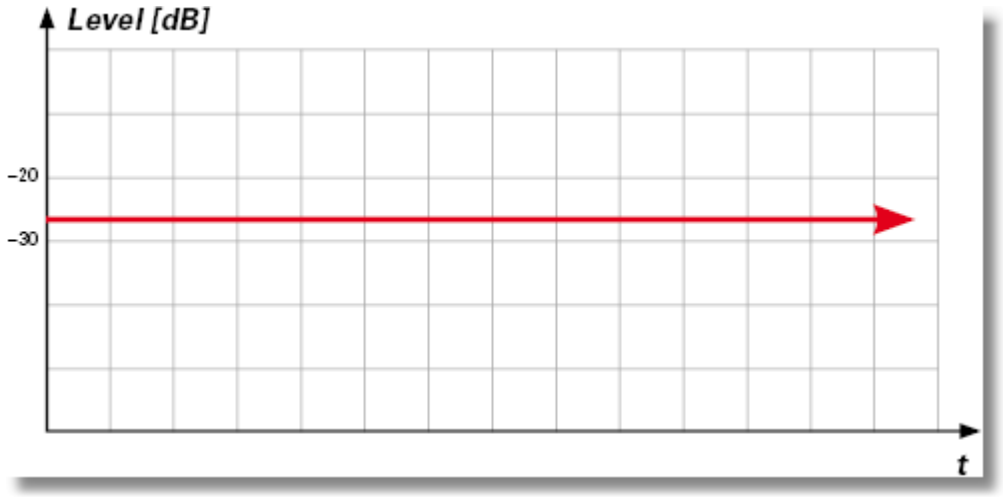
Time sweep

FX100 records the active measurement(s) over time, during which an optional test signal may be generated



Example of generated test signal during a time sweep

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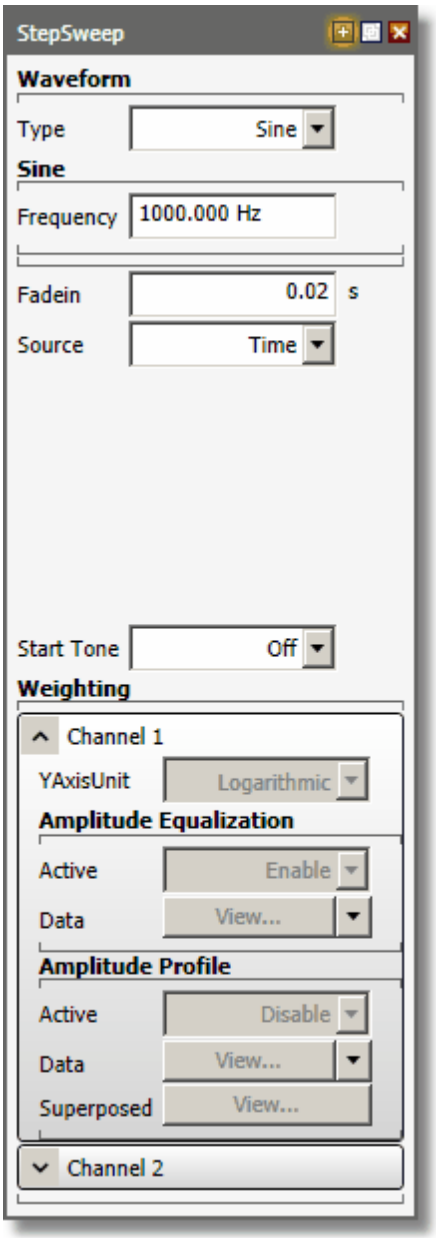

Waveform

Type → supported StepSweep test signal (i.e.Sine)

Sine

- Frequency → frequency of the generated sine wave
- Fadein → duration of generator fade-in before the sweep starts
- Source → Time
- Start Tone On → a 1 kHz start tone with fixed duration of 1 second is generated prior to the StepSweep execution

Hints ***If the time sweep is to be executed without generating a signal, simply mute the FX100 output channels***
The time sweep analyzer parameters have to be defined via the Analyzer StepSweep properties
The required StepSweep measurements have to be activated separately

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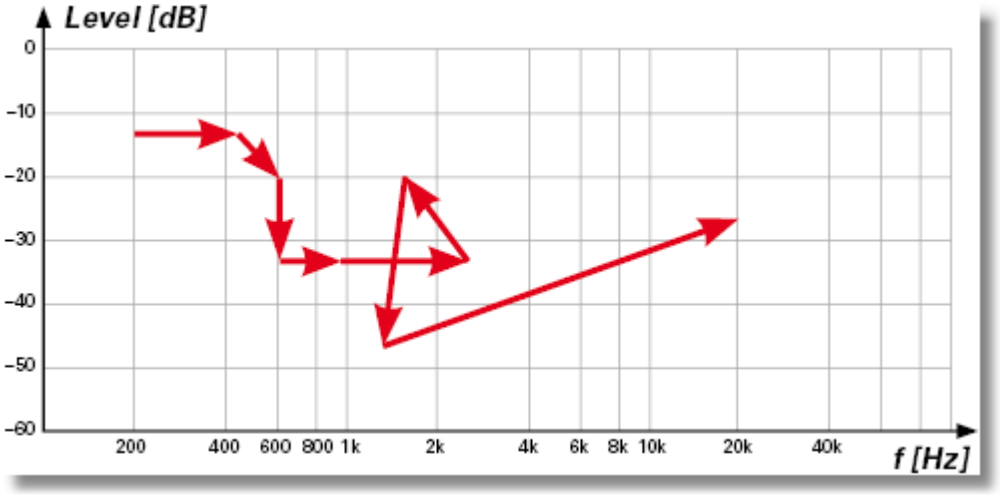
Table sweep

The level and frequency of the generated sine signal follow a user-defined table.



Example of generated table sweep test signal

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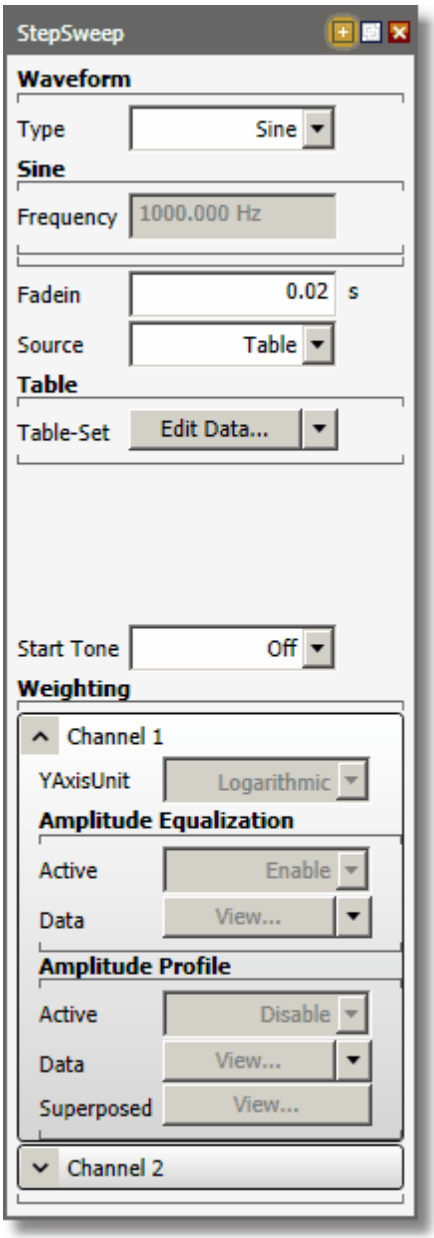


Waveform

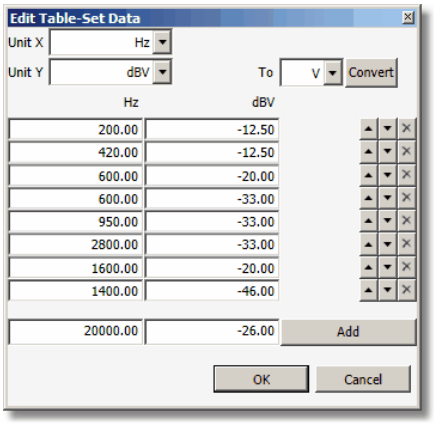
Type → supported StepSweep test signal (i.e.Sine)

Sine

- Fadein → duration of generator fade-in before the sweep starts
- Source → Table

Table-Set

- Edit Data → opens the panel that allows the definition of the table sweep frequency / amplitude values



  - Unit Y → select the measurement unit for the level values
  - To ... Convert → this button changes the level measurement unit in which the table is expressed
  - Add → enter the required frequency & level and click on the 'Add' button to add a new point to the table
  - → moves the corresponding line upwards by one position within the table
  - → moves the corresponding line downwards by one position within the table
  - → deletes the corresponding line from the table

Hint ***The table values may be defined in any order (i.e. rising and/or decreasing)***

  - Copy Data → copies the contents of the current table into the clipboard (minimum "V" and "Hz")
  - Paste Data → pastes the contents of the clipboard to the table (thus it is possible to import the table values from an existing file)

- Start Tone On → a 1 kHz start tone with fixed duration of 1 sec. is generated prior to the StepSweep execution

Hints ***The analyzer sweep parameters have to be defined via the Analyzer StepSweep properties***
The required StepSweep measurements have to be activated separately

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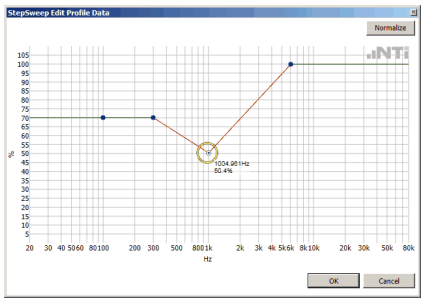
Amplitude profile

The StepSweep amplitude profile can be displayed and edited in two different ways.

a) Graphical editing



a) Enable the amplitude profile for the requested generator channel via the Generator StepSweep properties.

b) Click on the "Edit..." button to open the "StepSweep Edit Profile Data" panel.

c) Right-click on the graph and select "Add Point...", then place the cursor at the required level / frequency value, and confirm with a left-click.

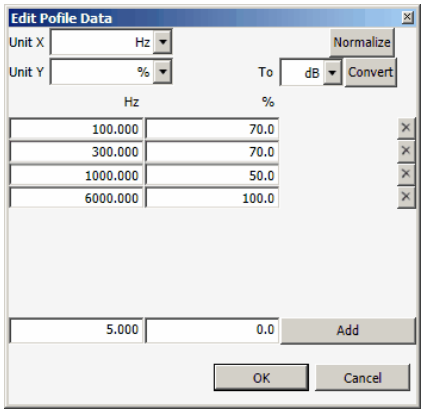
d) Amend the level, frequency of a profile point by left-clicking, holding on it and moving it to the desired position.

e) Click on the "Normalize" button to make sure that the level of the highest point(s) in the profile equals 100%.

f) Click on the "OK" button to confirm the current profile & close the panel.

Hint ***Please observe the aforementioned StepSweep amplitude profile definition.***

b) Numerical editing



a) Enable the amplitude profile for the requested generator channel via the generator StepSweep properties.

b) Click on the "Edit..." button to open the "StepSweep Edit Profile Data" panel.

c) Right-click on the graph and select "Edit Data..." to open the "Edit Profile Data" panel.

d) Enter the numerical frequency & attenuation of a profile point and click on the "Add" button (click on the "Convert" button to toggle the attenuation between % or dB).

e) Amend the level or attenuation of a point by clicking on the corresponding input box.

f) Delete a point by clicking on the corresponding ✕ button.

g) Click on the "Normalize" button to make sure that the level of the highest point(s) in the profile equals 100%.

h) Click on the "OK" button to confirm the current profile & close the panel.

Hint ***Please observe the aforementioned StepSweep amplitude profile definition.***

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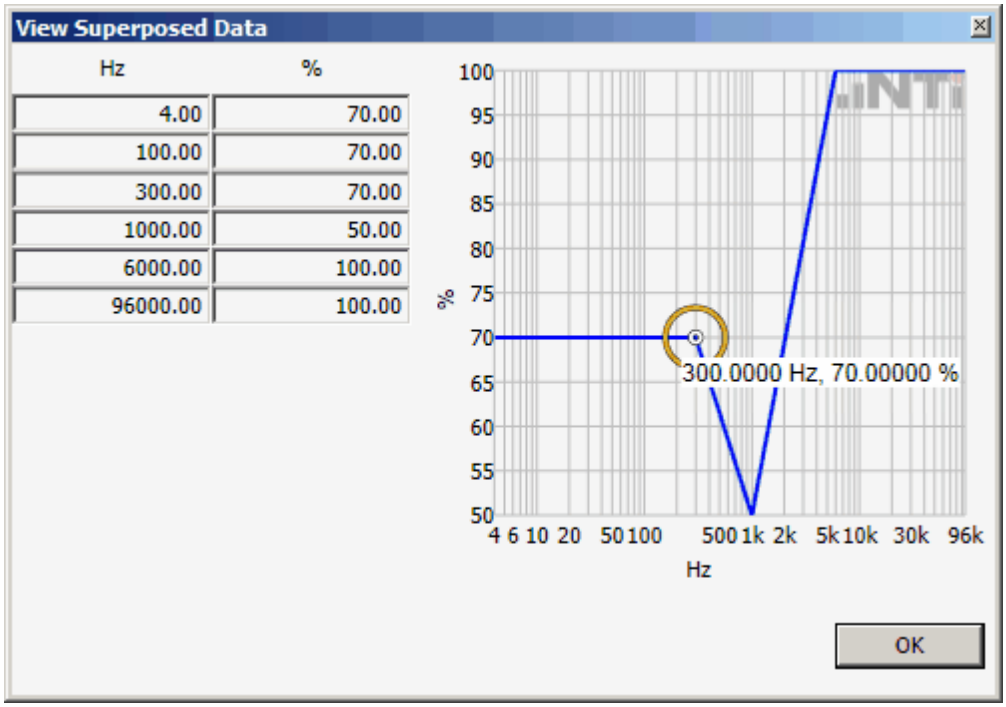
c) View profile

Click on the "Superposed View..." button to show the currently active amplitude profile numerically and graphically.



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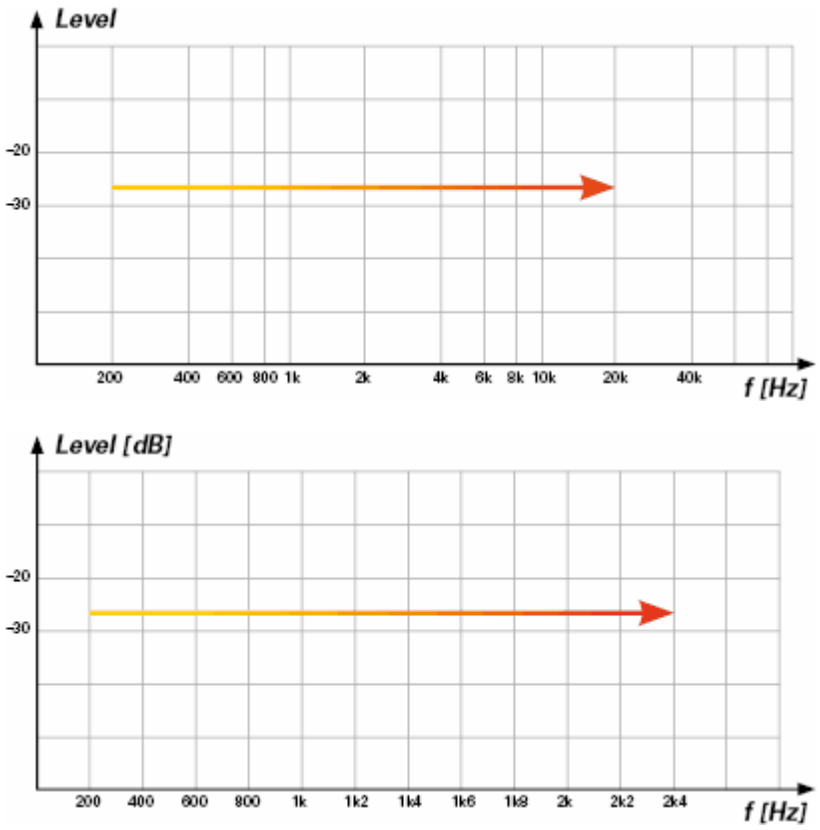
4.6 GlideSweep

FX100 supports the generation of either logarithmic or linear chirps, whereby a sine wave sweeps continuously over a frequency range.

NOTE Only PureSound analysis, and not level, distortion etc. measurements are possible with Linear GlideSweep transmission



Examples of generated logarithmic, linear GlideSweep test signals

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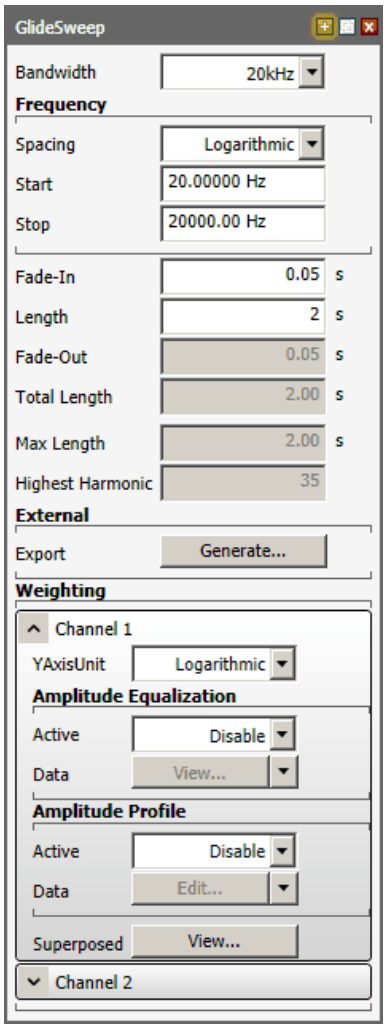
Generator properties



Bandwidth

The bandwidth of the FX100 analyzer can be limited to 20 kHz in order to prolong the maximum GlideSweep duration.

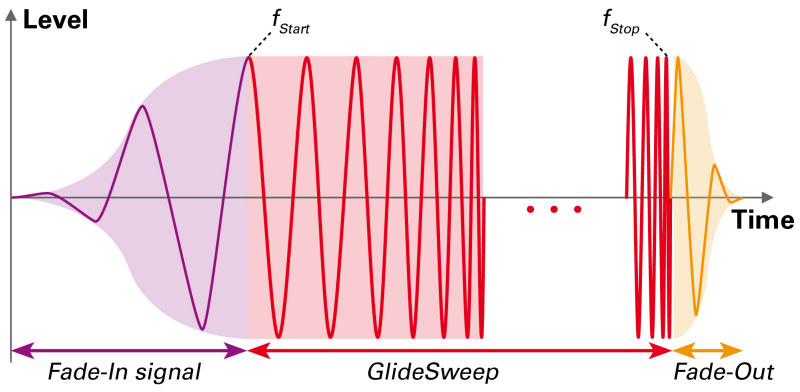
- 20kHz → max. 40 seconds GlideSweep duration
- 80kHz → max. 10 seconds GlideSweep duration

Frequency

- Spacing
  - Linear → the rate at which the sweep moves over the frequency axis is linear (NOTE: level or distortion measurements are not possible with linear GlideSweep transmission)
  - Logarithmic → the rate at which the sweep moves over the frequency axis is logarithmic
- Start → start frequency of GlideSweep (must be < stop frequency)
- Stop → stop frequency of GlideSweep (must be > start frequency)

NOTE The difference between the Start → Stop frequency must be greater than 1/3rd octave. Please observe also chapter "GlideSweep artifacts".

- Fade-In → user-defined duration of a special signal that precedes every GlideSweep
- Length → user-defined duration of the GlideSweep
- Fade-Out → duration of the terminating signal (not editable)
- Total Length → overall duration of Fadein + Length + Fadeout (not editable)
- Max Length → maximum possible length of the GlideSweep (depends on start, stop frequencies; not editable)
- Highest Harmonic → uppermost harmonic that can be measured (depends on start, stop frequencies; not editable)



Hint The Fade-In signal duration should be about 5 x 1/f_{Start} (e.g. f_{Start} = 20 Hz → Fade-In = 0.25 s)

External

Export → click on the "Generate..." button to generate a wav or mp3 file with the current GlideSweep (*see below*)

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Weighting

An individual weighting of the generated GlideSweep signal can be applied to each channel. It allows you, for instance, to equalize the generator output, or to apply a user-defined amplitude profile. In either case, neither the GlideSweep spacing nor duration are affected.

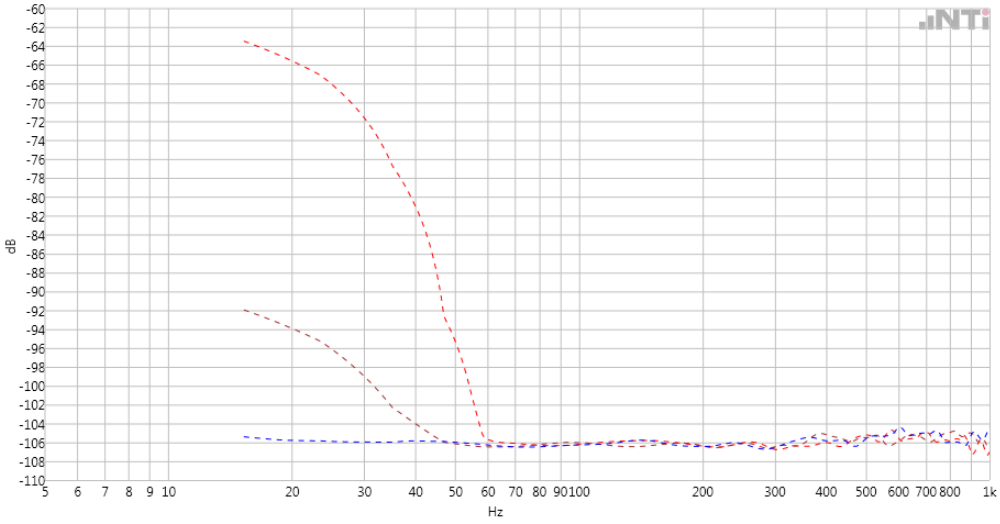
- YAxisUnit
  - Linear → the generated signal level between GlideSweep points is interpolated linearly
  - Logarithmic → the generated signal level between GlideSweep points is interpolated logarithmically
- **Amplitude equalization**
  - Enable → activates the generator equalization
  - Data View → shows the current values of the generator equalization file
  - Data Copy → copies the contents of the generator equalization file to the clipboard
  - Data Paste → pastes the clipboard contents to the generator equalization file
- **Amplitude profile** (*see below*)
  - Enable → activates the amplitude profile feature
  - Data Edit... → opens a graph with the current amplitude profile
  - Data Copy → copies the numerical values of the current profile to the clipboard
  - Data Paste → pastes the numerical data from the clipboard to the profile
  - Superposed View... → shows the superposed amplitude equalization + profile weightings.

Hints ***The GlideSweep analyzer parameters have to be defined via the corresponding analyzer properties; the required GlideSweep measurements have to be activated separately. Mute the FX100 output channels if an externally-generated GlideSweep is being analyzed.***

GlideSweep artifacts

Due to the nature of the GlideSweep measurement, artifacts can occur in the low-frequency region. These artifacts become noticeable in the form of increased THD (i.e. harmonic distortions) measurement results. The amount of these artifacts and the affected frequencies depend on the particular GlideSweep parameters.

The same limitation applies also for acoustical measurements, where the low frequency noise can interfere with the synchronization. This can also result in measurement errors.



Distortion artifacts in low-frequency GlideSweep region

Since the artifacts can degrade the accuracy of a THD, distortion measurement, it is advised to apply a minimum GlideSweep Length (i.e. duration), which depends on the Start frequency that has to be measured.

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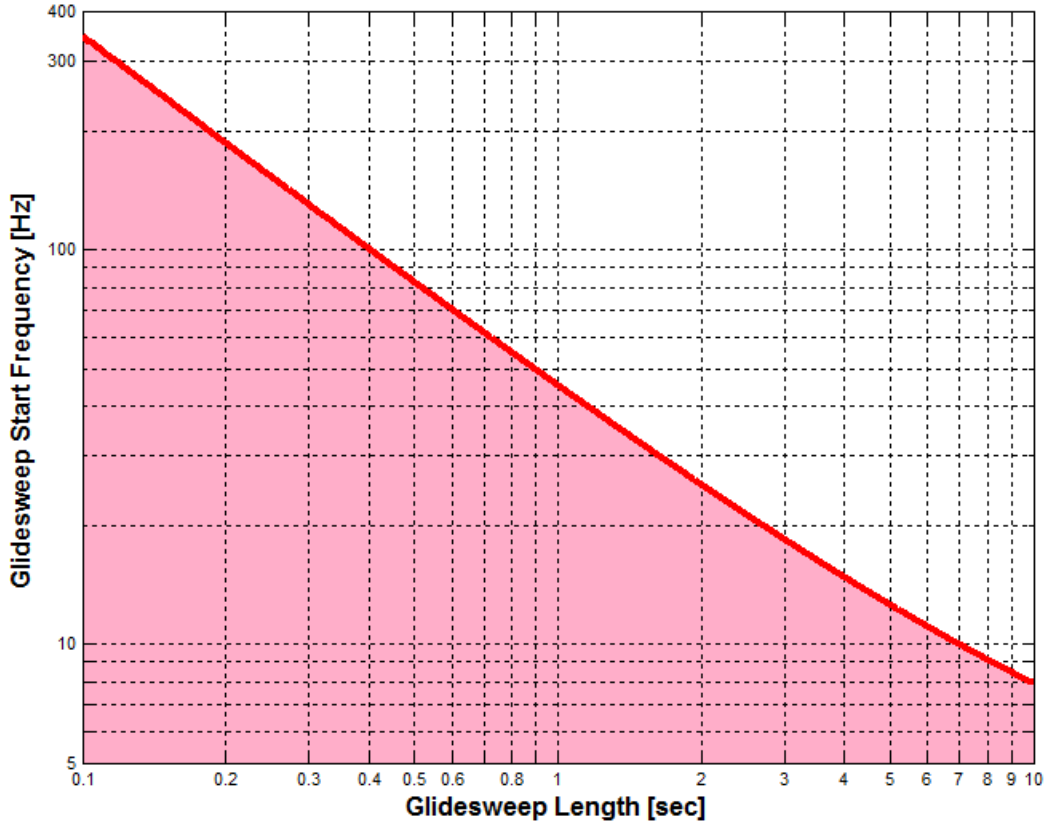
The relation between Glidesweep Start frequency and Length is shown by the following curve. Any setting below the red line may show artifacts and should therefore be avoided.



Critical area of GlideSweep Start frequency / Length settings

In addition to the aforementioned effects, the GlideSweep analysis is sensitive to DC offset voltages at the analyzer inputs. Such offset voltages may come e.g. from the DUT, but also occur after switching from a different measurement mode (e.g. Meter or StepSweep) or after changing the input range.

The impact of this sensitivity can be minimized by following measures:

- Allow enough time between switching the FX100 from Meter or StepSweep mode to GlideSweep analysis.
- Adjust the input range and the GlideSweep range to the same value.
- Increase the duration of the Fade-In.

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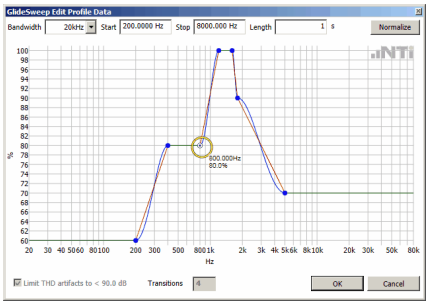
Amplitude profile

The GlideSweep amplitude profile can be displayed or edited in two different ways.

NOTE Please observe the following restrictions

- **The number of transitions in a GlideSweep amplitude profile is limited to six (6).**
- **Every transition is automatically smoothed by the system.**
- **If a transition gets too steep, it will be shown as a dotted line together with the message "Invalid Transitions".**

a) Graphical editing



a) Enable the amplitude profile for the requested generator channel via the generator GlideSweep properties.

b) Click on the "Edit..." button to open the "GlideSweep Edit Profile Data" panel. The top line of the panel shows the GlideSweep parameters that may be amended, e.g. if required due to the amplitude profile restrictions.

c) Right-click on the graph and select "Add Point...", then place the cursor at the required level / frequency value, and confirm with a left-click.

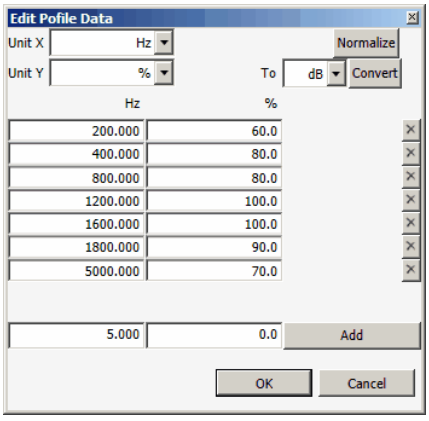
d) Amend the level, frequency of a profile point by left-clicking, holding on it and moving it to the desired position.

e) Click on the "Normalize" button to make sure that the level of the highest point(s) in the profile equals 100%.

f) Click on the "OK" button to confirm the current profile & close the panel.

Hint Please observe the aforementioned GlideSweep amplitude profile definition.

b) Numerical editing



a) Enable the amplitude profile for the requested generator channel via the generator GlideSweep properties.

b) Click on the "Edit..." button to open the "GlideSweep Edit Profile Data" panel.

c) Right-click on the graph and select "Edit Data..." to open the "Edit Profile Data" panel.

d) Enter the numerical frequency & attenuation of a profile point and click on the "Add" button (click on the "Convert" button to toggle the attenuation between % or dB).

e) Amend the level or attenuation of a point by clicking on the corresponding input box.

f) Delete a point by clicking on the corresponding button.

g) Click on the "Normalize" button to make sure that the level of the highest point(s) in the profile equals 100%.

h) Click on the "OK" button to confirm the current profile & close the panel.

Hint Please observe the aforementioned GlideSweep amplitude profile definition.

c) View profile

Click on the "Superposed View..." button to show the actual amplitude profile numerically and graphically.

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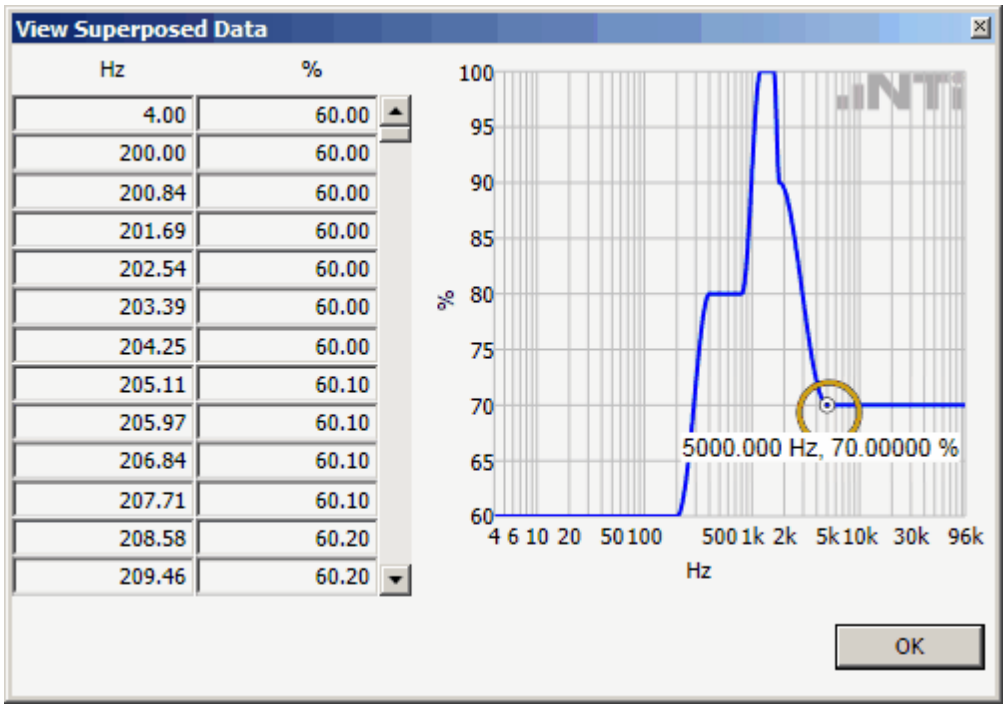
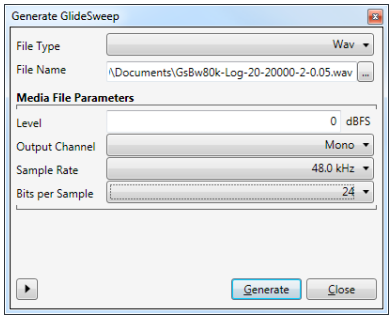


Export GlideSweep

FX-Control allows to export the current GlideSweep, i.e. to create a wav or mp3 file of the GlideSweep. This file can then be replayed by an external device, and analyzed by FX100.

- The spacing of the exported GlideSweep can be linear or logarithmic
- The GlideSweep is always exported WITHOUT any weighting.
- The GlideSweep sound file always starts with a fixed header that allows the FX100 analyzer to trigger & synchronize correctly to the incoming signal.

NOTE It is essential that the GlideSweep generator parameters of the analyzing FX100 are identical to those of the externally replayed GlideSweep signal.



- File Type → select 'Wav' (recommended) or 'Mp3' format according to your demands.
- File Name → FX-Control automatically proposes a file name in the default directory (can be edited).
- Attenuation → output level attenuation of the generated GlideSweep (–80 dB to 0 dB)
- Output Channel → the sound file can be generated with the GlideSweep on
  - Mono (1-chn signal)
  - Stereo Both (2-chn signal)
  - Stereo Left (2-chn signal, but right channel muted)
  - Stereo Right (2-chn signal, but left channel muted)
- Sample Rate → select the sample rate of the GlideSweep sound file fitting to the replay device.
- Bits per Sample → resolution (8, 16 or 24 bits) of the generated GlideSweep.

Click on the 'Generate' button to create & save the GlideSweep sound file.

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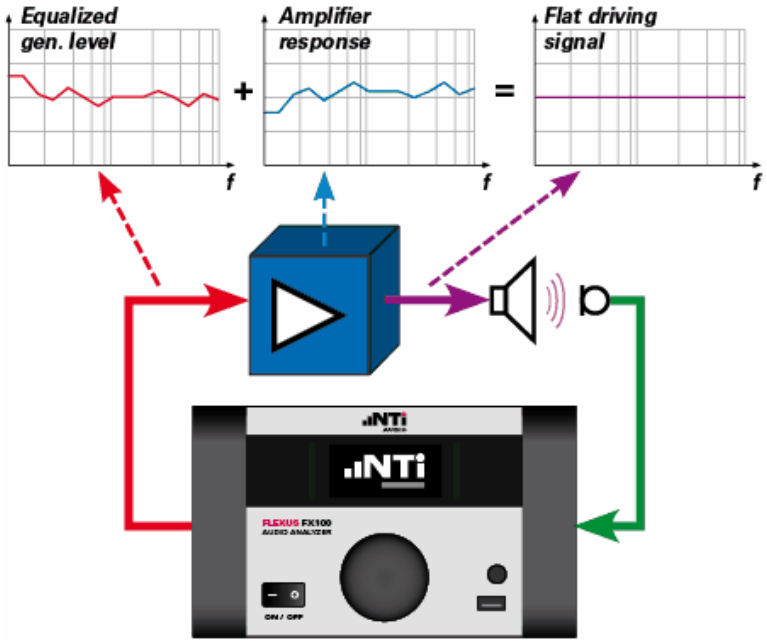
4.7 Weighting

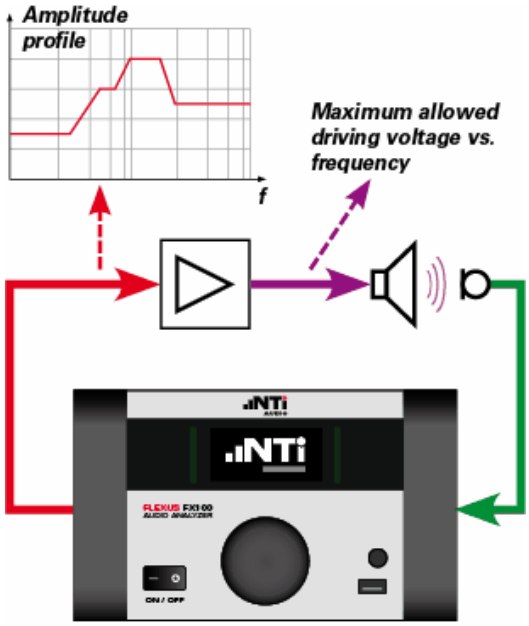
The term 'weighting' refers to the ability of FX100 to shape the level vs. frequency of a generated StepSweep or GlideSweep. There are two different weighting types for the following applications,

a) Amplitude equalization



The amplitude equalization compensates, e.g. the characteristics of an external amplifier, thus resulting in a flat frequency response at the speaker input pins (refer to regulators, generator equalization)

b) Amplitude profile



Amplitude profiles are used to drive a transducer at its maximum allowed level over the frequency range (refer to chapters StepSweep, GlideSweep amplitude profile)

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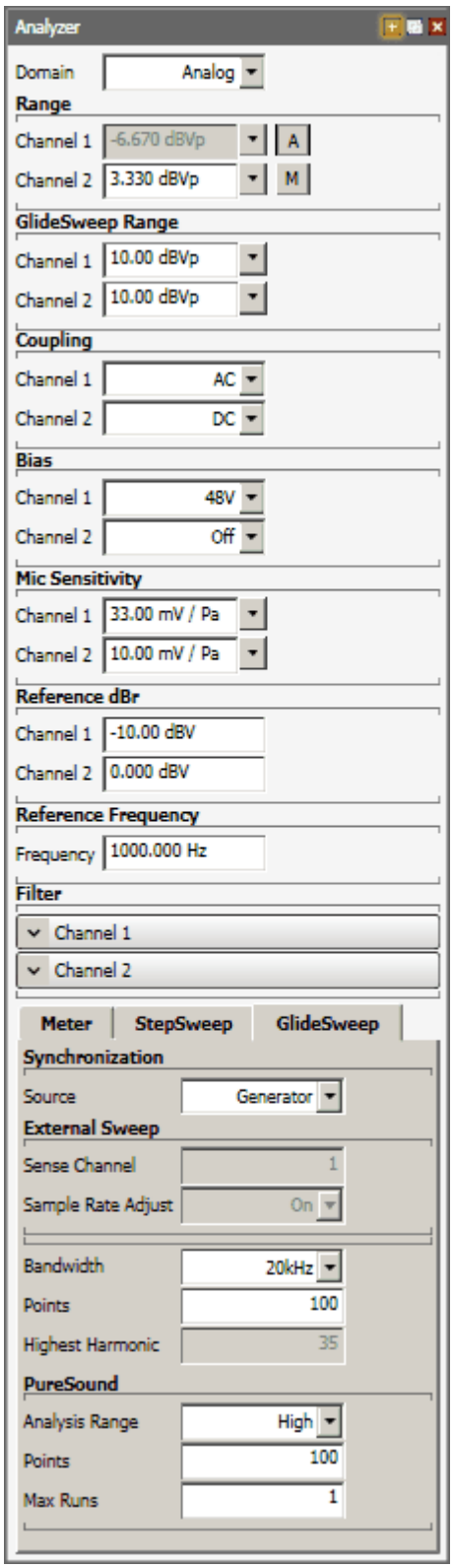
Part V

5 Analyzer settings

FX100 is able to analyze internally or externally generated Meter, StepSweep or GlideSweep test signals.

Hint ***In case of external signal analysis, special attention must be paid to properly synchronizing the analyzer***



To get access to the editable properties of the available input channels,

- drag & drop the required analyzer panels to the WorkArea, or
- use the analyzer properties

Numerical values (e.g. input range, mic sensitivity, start/ stop frequencies)

Click on an input box and adjust the value as follows.

- Exact value: enter the required value directly via the keyboard (e.g. "0.514" or "8k" etc.)
- Stepwise: use the up, down arrow keys or the scroll wheel of your mouse

Measurement Units (e.g. Vp, dBu, dBV)

There are two ways to select the level measurement unit.

1. Click on the button and select the required unit
2. Enter the unit directly together with the level (e.g. "320mV" or "-12.5 dBVp" etc.)

States (e.g. coupling, bias, filter)

Click on the button and select the required state.

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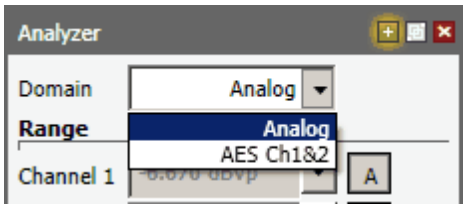
5.1 Domain

Hint ***The property "Domain" is only available if the FX-AES board is installed.***

If the analyzer is switched to digital domain, the domain-specific properties will be displayed in blue color.



The FX100 analyzer can be switched to analog or digital domain via the properties in the

- Hardware & Wiring or
- Worksheets view.

NOTE **The analyzer reference dBr and the tolerance limits are handled independently in the analog, digital domain. If you amend e.g. the digital reference level, the previously adjusted analog reference level will not be changed.**

5.2 Range (Meter, StepSweep)

The input range represents the 'sensitivity' of the FX100 analyzer.

Proper adjustment of the input range is essential to

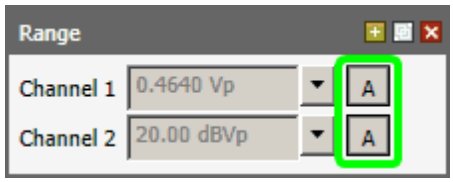
- avoid clipping, and
- ensure accurate measurement results.

Automated ranging

Auto ranging is recommended if the input signal level is unknown prior to the measurement.

In this mode, a special circuit in FX100

- continuously monitors the input signal level (i.e. also during the measurement),
- automatically adapts the analyzer sensitivity.



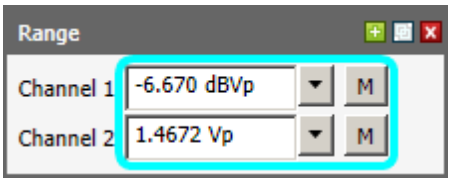
Manual range

Manual ranging is recommended

- if the input signal shows a rapidly changing level, and/or
- to speed up the measurement.

The operator has to manually enter an appropriate analyzer range prior to the measurement.

The input range must be defined in terms of a peak measurement unit, i.e. Vp, dBVp or dBup



NOTE **The input range is divided in fixed stages, i.e. a manually-entered value may be rounded to the next higher stage.**

The GlideSweep input range must be adjusted separately

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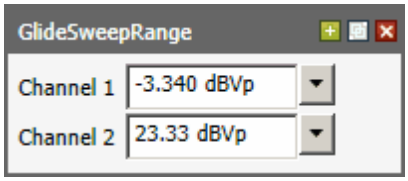
5.3 GlideSweep range

Proper adjustment of the GlideSweep range (i.e. the 'sensitivity' of the FX100 analyzer) is essential to

- avoid clipping, and
- ensure accurate measurement results.

The GlideSweep range must be adjusted prior to the signal acquisition, either

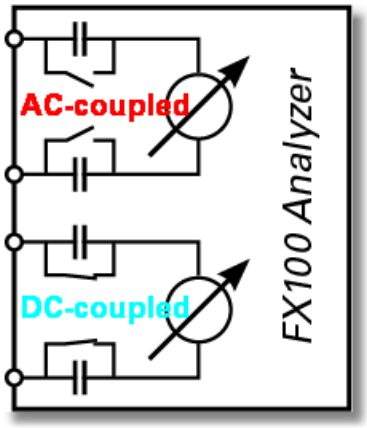
- manually by entering an appropriate range, or
- automatically via the 'GlideSweep Range' regulator

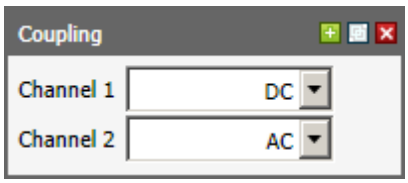


5.4 Coupling

The FX100 input stage is AC-coupled by default, i.e. any DC signal component (e.g. Phantom power) that is present at the input connector will be filtered out.

Alternatively, the DC-coupling can be activated, so that a DC-offset at the input connectors will also go into the measurement result.





Hint ***If the input is AC-coupled, a change of the bias to/from 48 V, 2 V or ICP* may cause that the analyzer input capacitor gets charged, which may take some time. In this case, the FX100 analyzer detects the charging process and applies a 1.2 s timeout in order to ensure a stable input signal and thus correct measurement result. Consequently, the overall measuring speed may be compromized in applications where the input connectors are repeatedly switched between different bias settings.***

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5.5 Bias

The term 'Bias' stands for an optional offset voltage or current that is applied to an input connector.

With the FX100 it is possible to activate different types of bias on input channels.

Off	⇒ No bias (default)
2 V	⇒ Phantom power for 2 V microphones
48 V	⇒ Phantom power for 48 V microphones
DCR 5k range	⇒ the analyzer generates a 1.6 mA current to measure the output impedance of the DUT (Device Under Test) (up to 5 kΩ)
DCR 100k range	⇒ the analyzer generates a 100 µA current to measure the output impedance of the DUT (up to 100 kΩ)
ICP*	⇒ constant current microphone power supply (4 mA)

NOTE **As soon as a microphone is added to the Hardware & Wiring and connected to an FX100 input ⇒ the bias of the corresponding channel is only accessible via the microphone properties in the Hardware & Wiring view.**

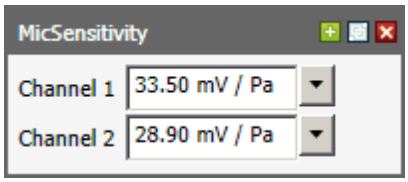
Hint ***If the input is AC-coupled, a change of the bias to/from 48 V, 2 V or ICP* may cause that the analyzer input capacitor gets charged, which may take some time. In this case, the FX100 analyzer detects the charging process and applies a 1.2 s timeout in order to ensure a stable input signal and thus correct measurement result. Consequently, the overall measuring speed may be compromized in applications where the input connectors are repeatedly switched between different bias settings.***

**: ICP® is a registered trademark of PCB Piezotronics*

5.6 Microphone sensitivity

The sensitivity of any microphone that is connected to an FX100 input must be entered properly to ensure correct measurements.

The microphone sensitivity is expressed either in [mV/Pa] or [dBV/Pa], and can be edited in the properties section of the Hardware & Wiring view or the Worksheets.



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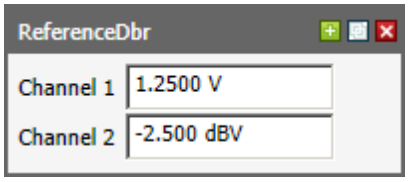
5.7 Reference dBr

The panel allows to manually enter the reference value for the dBr level, distortion measurements.



Supported measurement units and ranges of the reference value

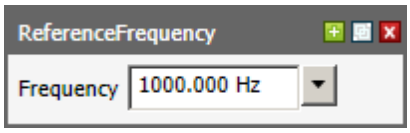
- Volt: 0.0001 µV .... 10 MV
- dBV: -200...+200 dBV
- dBPa: (*range depends on microphone sensitivity*)
- dBSPL: (*range depends on microphone sensitivity*)
- dBu: -197.8...202.2 dBu

Hint ***Alternatively, you may press Ctrl + 1 (or 2) or right-click on the Meter.Level panel in order to assign the actual input level of channel 1 or 2 as the new reference level.***

5.8 Reference frequency

Enter the reference value for frequency measurements expressed in ppmr.

The reference frequency is freely adjustable from 5 Hz to 80 kHz.



Hint ***Please refer also to the calculation item "Sample Rate Deviation"***.

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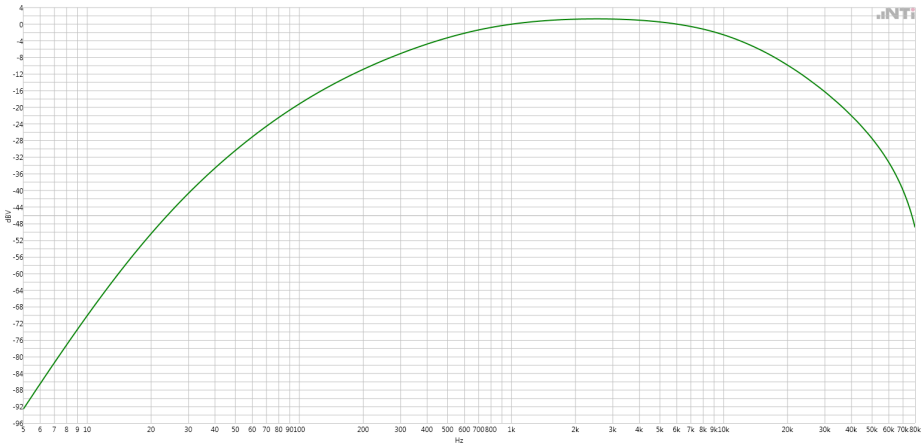
5.9 Filter

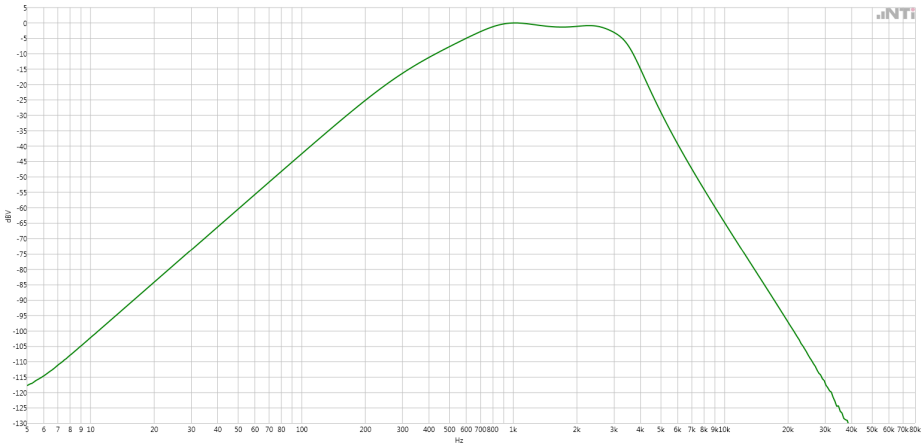
FX100 features a number of frequency weightings and filters.

Weighting	*HighPass filter*	*LowPass filter*
• A-weighting • C-weighting	• 10 Hz • 22.4 Hz • 100 Hz • 300 Hz • 400Hz	• 3.4 kHz • 8 kHz • 15 kHz • 20 kHz brickwall (AES17) • 22.4 kHz • 40 kHz

A-weighting



C-weighting



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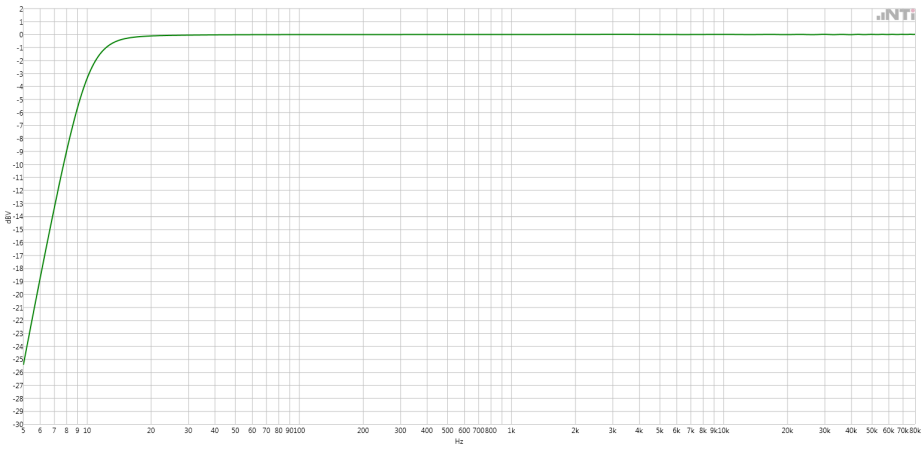
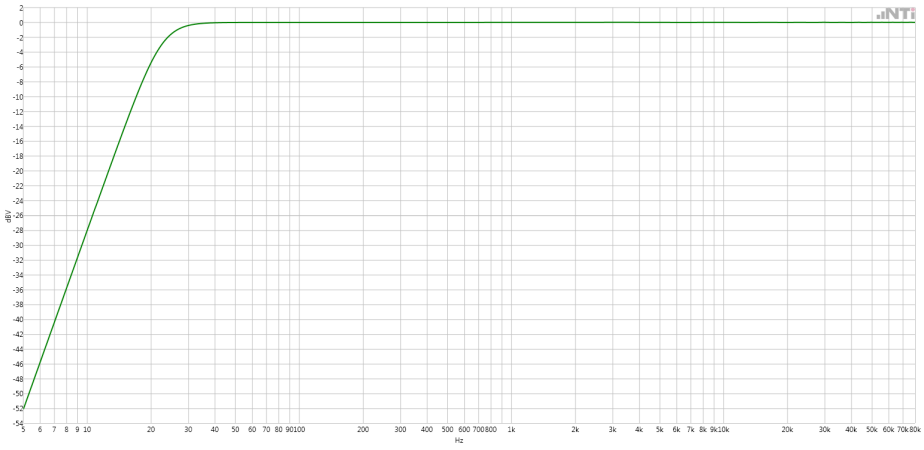
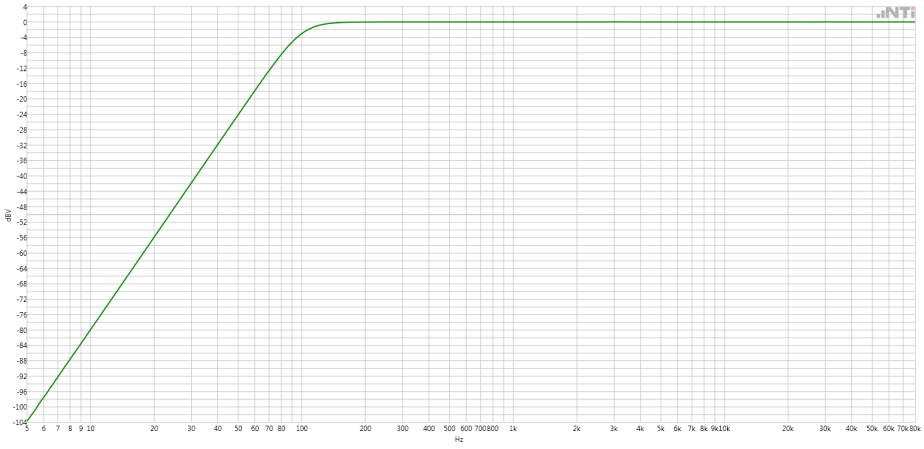
HighPass 10 Hz



HighPass 22.4 Hz



HighPass 100 Hz



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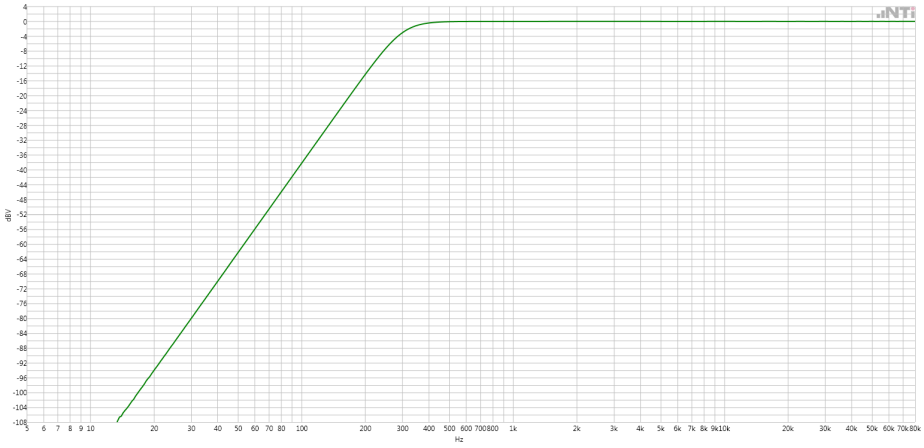
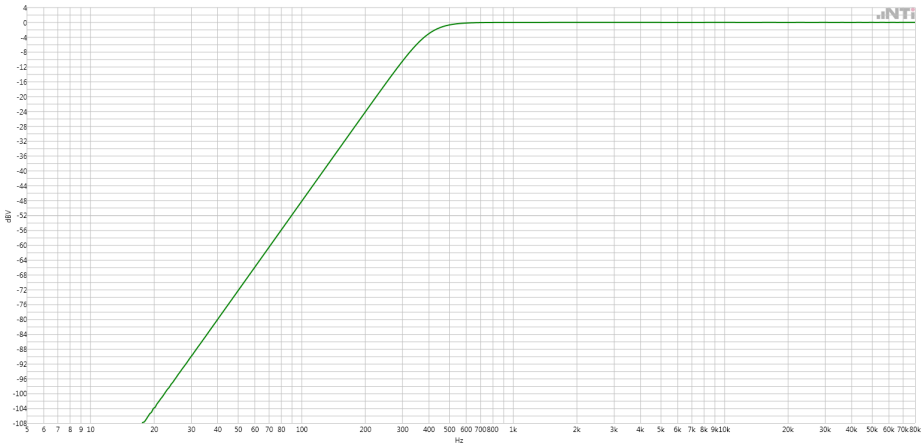
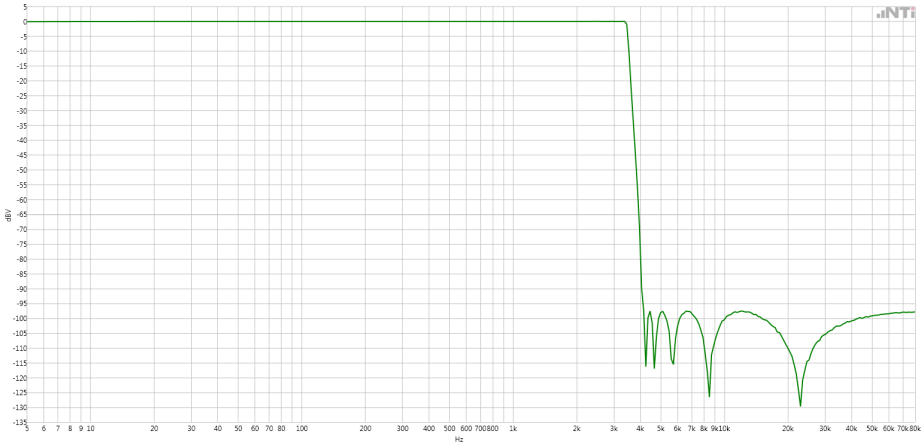
HighPass 300 Hz



HighPass 400 Hz



LowPass 3.4 kHz



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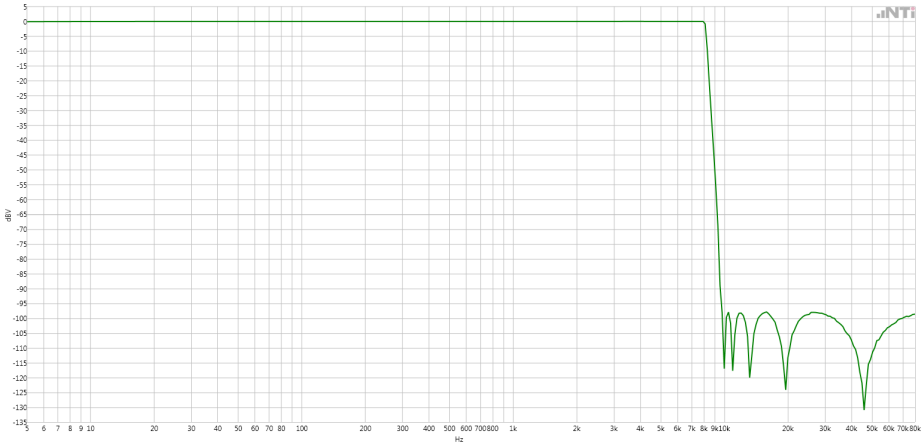
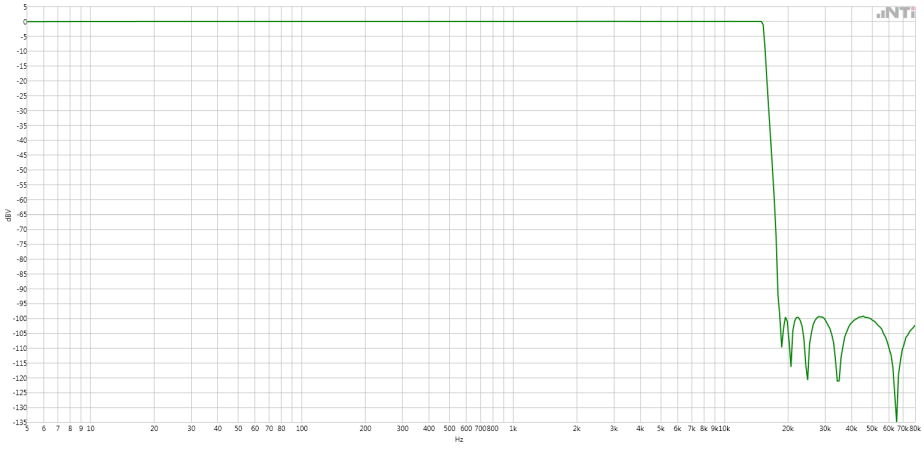
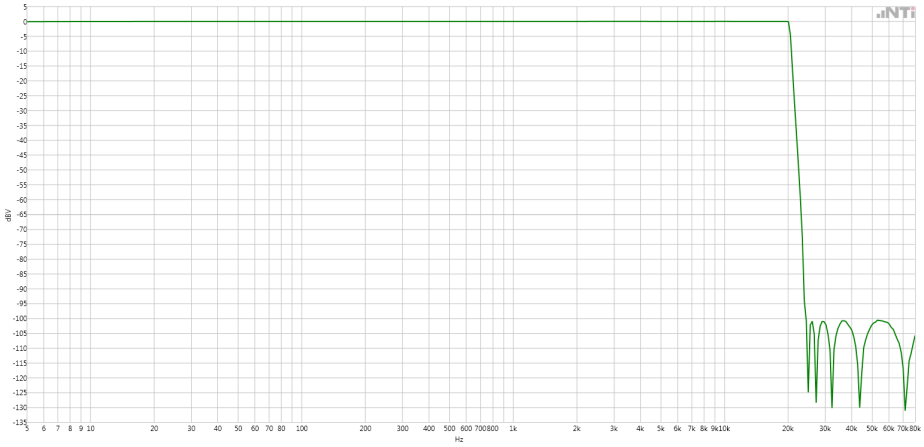
LowPass 8 kHz



LowPass 15 kHz



LowPass 20 kHz brickwall



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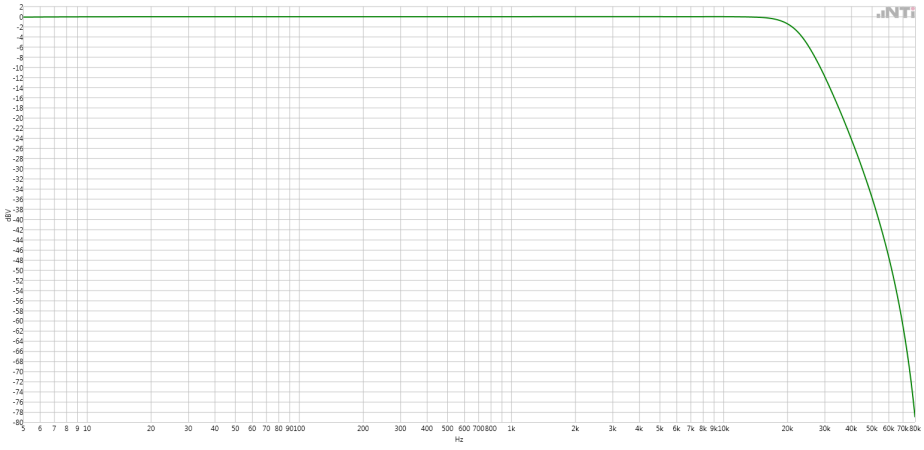
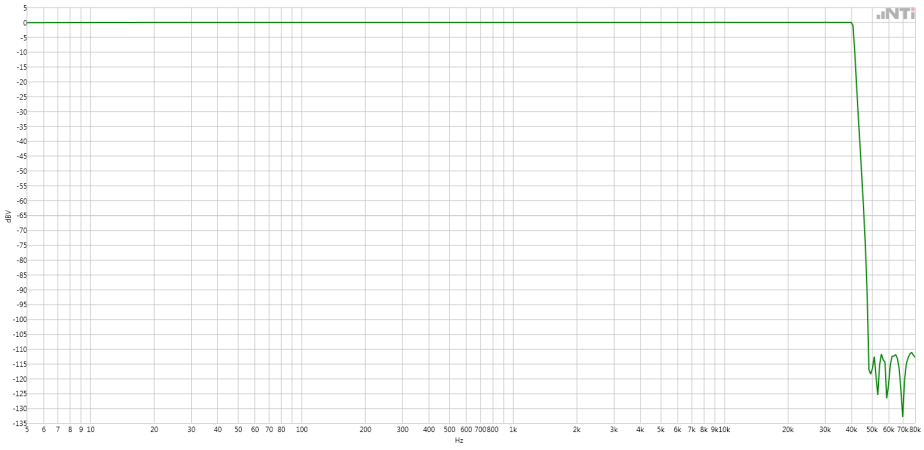
LowPass 22.4 kHz



LowPass 40 kHz



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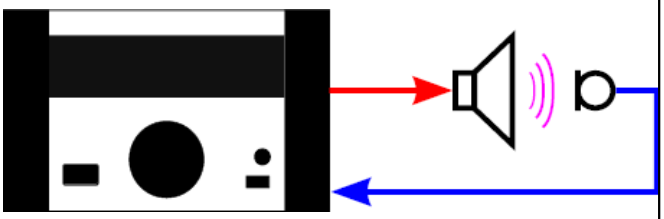
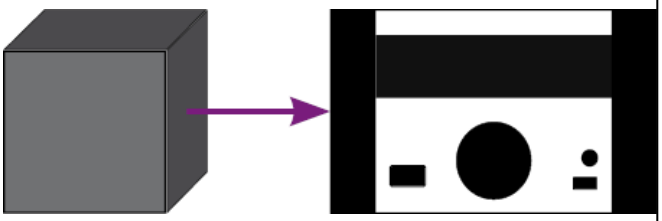
5.10 Synchronization

FX100 supports the analysis of internally or externally generated signals. In both cases, the analyzer and the test signal generator must be synchronized properly.

The synchronization can be adjusted individually for Meter and StepSweep analysis via the Analyzer properties.

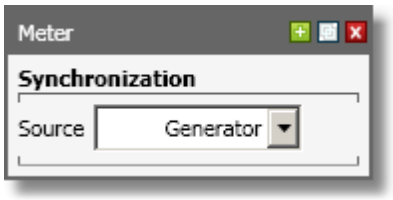
Internal	External
	
• The analyzer is directly synchronized to the FX100 generator frequency. • This mode allows maximum measurement speed without compromising accuracy.	• The FX100 analyzer synchronizes automatically to the incoming signal. • This mode supports applications where the test signal is generated by an external device.

NOTE **If the synchronization source is set to 'Generator', some sweep parameters have to be defined via the Generator properties.**
If the synchronization source is set to 'External', also the Analyzer properties must be adjusted (see chapter 'Application hints → External signal analysis').

5.11 Meter

The Meter analysis is either synchronized to

- source generator or
- external signal source (i.e. dominant frequency of the incoming signal)



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5.12 StepSweep

FX100 supports four different StepSweep modes.

a) Frequency → the frequency of the generated test signal changes according to the user settings, while the signal amplitude remains constant

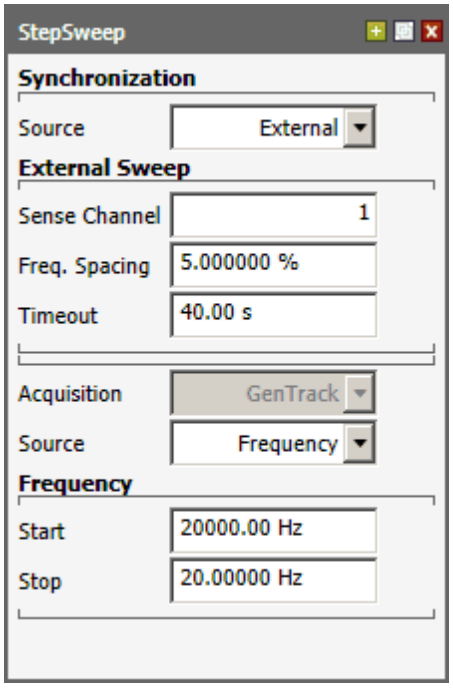
b) Amplitude → the level of the generated sine wave changes according to the user settings, while the signal frequency remains constant

c) Time → the measurements are acquired over a user-defined time period

d) Table → a sequence of isolated test signals with individual levels & frequencies is generated according to the user settings

NOTE If the synchronization source is switched to 'External', some StepSweep parameters are only accessible via the Analyzer properties.
Otherwise, i.e. in case of an internal sweep analysis, these parameters must be defined via the Generator properties.

NOTE If a noise level vs. frequency is to be measured, the analyzer synchronization must be switched to 'Generator' and the acquisition to 'Wideband'.



Synchronization

Source

- Generator → the analyzer StepSweep acquisition is controlled by the generator
- External → the FX100 analyzer synchronizes to an external signal source (i.e. the frequency of the dominant input signal)

External Sweep (*only accessible with synchronization source 'External'*)

- Sense Channel → active input channel
- Freq. Spacing → minimum frequency difference that is required to be accepted as a new step
- Timeout → the data acquisition is automatically aborted, if no stable sine signal step of an externally generated StepSweep is received within this period (max. 120 sec.)
- Acquisition (*only accessible with synchronization source 'Generator'*)
  - Wideband → the analyzes looks for the dominant frequency in the incoming signal, regardless of the actual generated sweep frequency
  - GenTrack → the analyzer is directly linked to the FX100 generator, and thus measures only the actual sweep frequency
- Type → Frequency, Amplitude, Time or Table (*see above*)

Frequency (*only accessible with synchronization source 'External'*)

- Start → start frequency of the incoming StepSweep (e.g. 20 Hz; Start frequency may be > Stop frequency)
- Stop → end frequency of the incoming StepSweep (e.g. 20 kHz; Stop frequency may be > Start frequency)

Hint In case of an externally generated StepSweep, the step duration depends on the start frequency.
Start frequency 10 Hz ⇒ 1 second step duration
Start frequency ≥ 20 Hz ⇒ 0.5 second step duration

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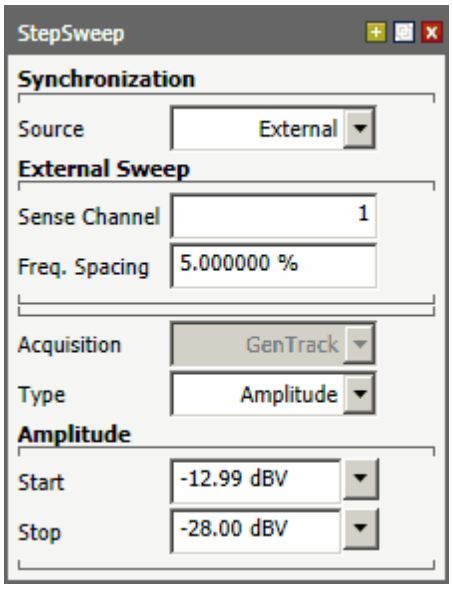
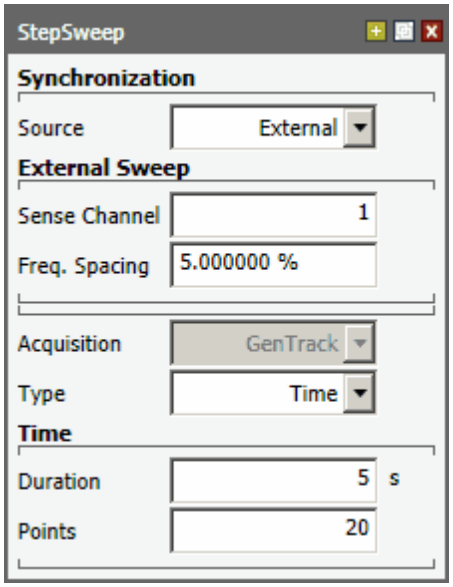


Amplitude (*only accessible with synchronization source 'External'*)

- Start → start level of the StepSweep (e.g. -20 dBV; Start amplitude may be > Stop amplitude)
- Stop → end level of the StepSweep (e.g. +10 dBV; Stop amplitude may be > Start amplitude



Time (*only accessible with synchronization source 'External'*)

- Duration → recording time period, expressed in seconds
- Points → number of measurements, which are equally distributed over the recording period

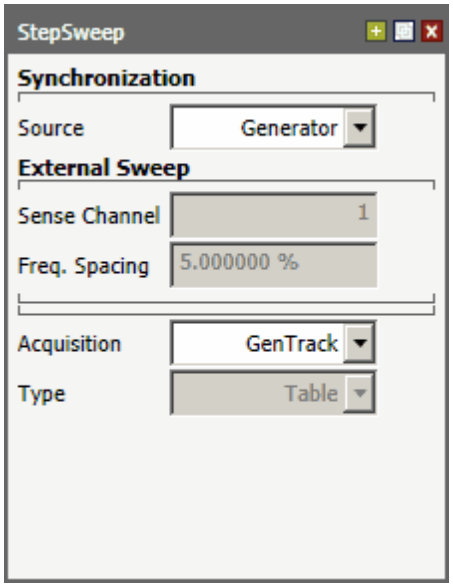


Table → definition of Table sweep parameters is only accessible via the Generator properties

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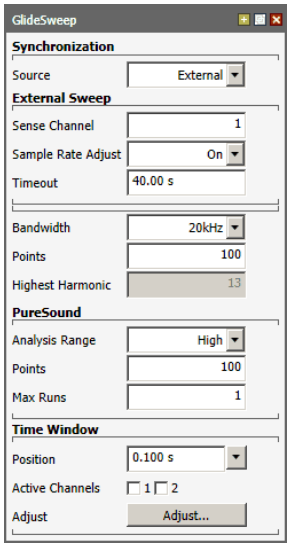
5.13 GlideSweep

FX100 supports the analysis of either logarithmic or linear chirps, whereby a sine wave sweeps continuously over a frequency range.

NOTE Only PureSound analysis, but not level, distortion etc. measurements are available in Linear GlideSweep transmission



Synchronization

- Source → select the signal source for the GlideSweep analysis
  - Generator → the FX100 analyzer triggers to and analyzes the internally generated GlideSweep
  - External → the FX100 analyzer triggers to and analyzes an externally generated GlideSweep

External Sweep

- Sense Channel → if the synchronization is set to "External", you can select an active input channel that shall trigger to the incoming GlideSweep signal

NOTE Make sure the sense channel is active, i.e. routed correctly in the Hardware & Wiring view

- Sample Rate Adjust → the FX100 analyzer synchronizes to the sample rate of the incoming GlideSweep
- Timeout → time period (max. 120 sec.), after which the data acquisition is automatically aborted if no external GlideSweep signal is received
- Bandwidth → the analyzer bandwidth has an impact on the max. GlideSweep duration
  - 20kHz → max. 40 seconds GlideSweep duration
  - 80kHz → max. 10 seconds GlideSweep duration
- Points → resolution of the GlideSweep analysis (max. 500 points)
- Highest harmonic → read-only indicator for the highest measurable harmonic (depends mainly on the GlideSweep start, stop frequency)

PureSound

- Analysis Range → PureSound filter bank (refer to measurement function 'PureSound')
- Points → resolution of the steepness analysis (max. 500 points)
- Max Runs → the number of times the PureSound test is repeated if the measurement results exceed the tolerance limits. The system then compares the data of the executed cycles to eliminate all non-recurring peaks (e.g stochastic ambient noise), and thus considers only systematic events (refer to measurement function 'PureSound').

NOTE The 'Max Runs' feature is only available in the synchronization mode 'Generator'

Time Window

The time window allows to limit the impulse response measurement, in order to exclude the impact of room reflections on the frequency response. The reflections that occur in a reverberant room can thus be filtered out by limiting the acquired impulse response of the system.

- Position → end point of the time window, expressed in milliseconds [ms] or meters [m] or feet [ft]

***Hint** The conversion distance → time refers to the ambient temperature that is defined via the toolbar 'Advanced → General'*

- Active Channels → enable or disable the time window for the corresponding analyzer channel(s)
- Adjust → click on this button to open the panel "Adjust Time Window"

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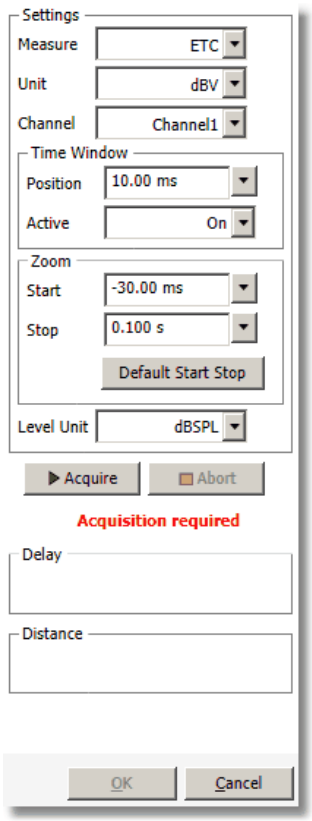
Adjust Time Window

The panel contains two graphs,

i. the ETC or Impulse response graph with the adjustable end point of the time window (vertical red bar)

ii. the Level curve, i.e. the frequency response that represents the impact of the impulse response time window

In other words, if the time window end point is moved within the ETC or Impulse response graph, the system directly shows the impact on the frequency response measurement.



Settings

- Measure → select the display mode
  - ETC (Energy-Time Curve) → envelope of the rectified impulse in logarithmic scale
  - Impulse → display of the calculated Impulse Response curve in linear scale
- Unit → supported units of the ETC (logarithmic) or Impulse response (linear) display modes.
- Channel → active channel
- Position → enter the end point of the time window, expressed in ms (milliseconds)

Hint ***To adjust the time window / vertical bar, right-click on the graph or numerically enter the position in [ms].***

- Active → enable or disable the time window
- Start, Stop → define the zoom range of the ETC or impulse response graph

Hint ***Use the mouse on the graph to directly zoom in.***

- Default Start Stop → undo the zoom = reset the Start / Stop time to their default values (i.e. –30 ms / 100 ms)
- Level Unit → supported units for the Level measurement (linear or logarithmic)

Control elements

- "Acquire" button → starts a measurement cycle (including signal acquisition)
- "Abort" button → aborts the ongoing measurement cycle
- Delay → the measured time delay from the signal source to the sensor (i.e. microphone)
- Distance → the calculated distance between the sound source (loudspeaker) and the microphone
- "OK", "Cancel" buttons → confirm or ignore the amendments ("OK" ⇒ applies the settings Position, Active, Level Unit and ETC or Impulse response Unit).

Example

The following two screenshots show the "Adjust Time Window" with an acquired measurement; the impact of placing the time window end point in front of the first reflections becomes clearly visible in the frequency response curve (less ripple).

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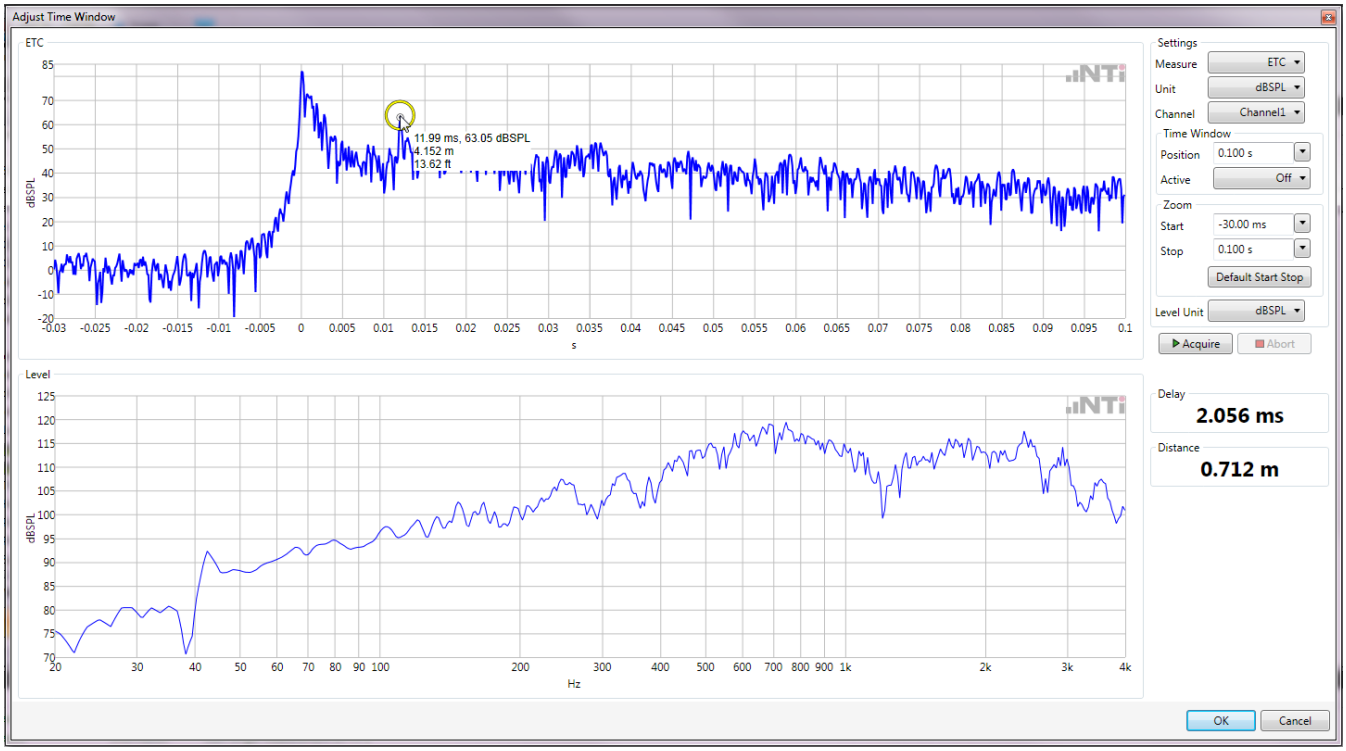
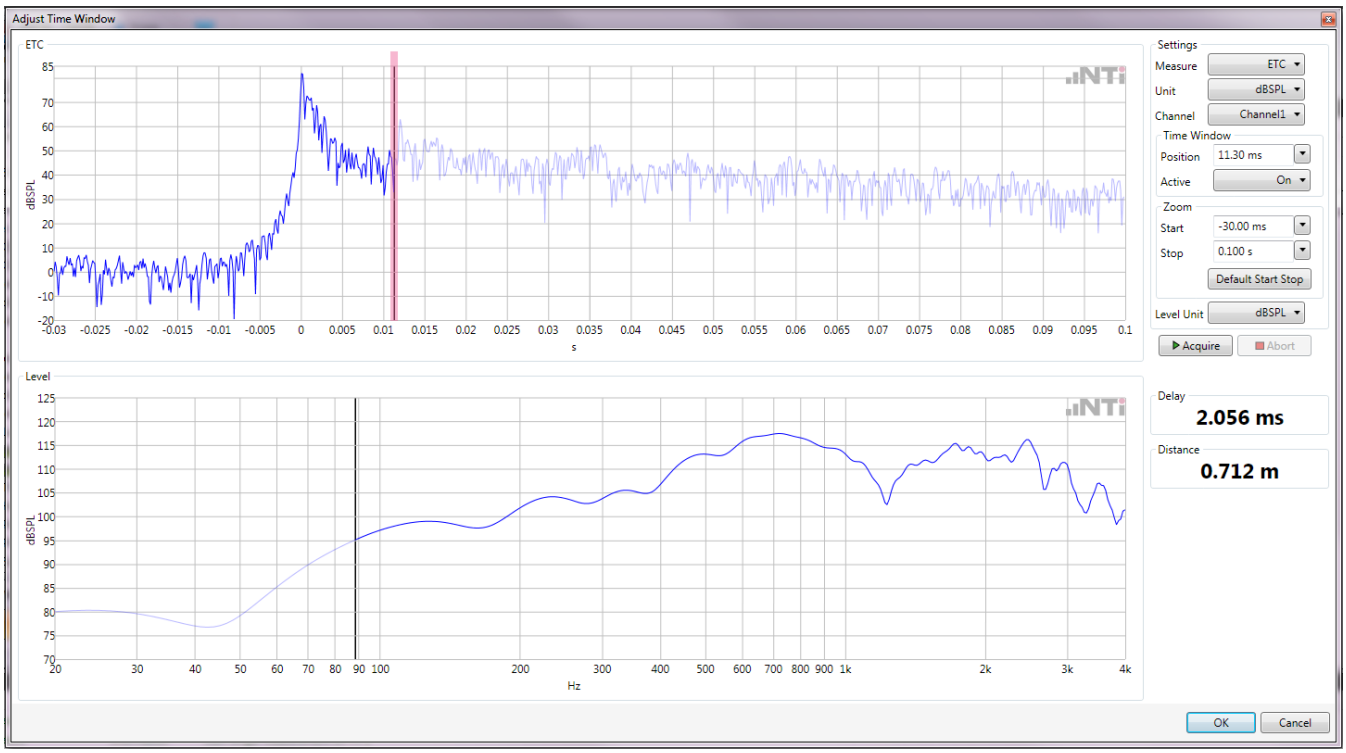


Time window end point at default position (i.e. @ 100 ms)



Time window end point placed in front of the first reflection (i.e. @ 12 ms)

Hint ***The grey bar in the low-frequency range of the Level graph indicates that the corresponding results become uncertain due to the time windowing.***

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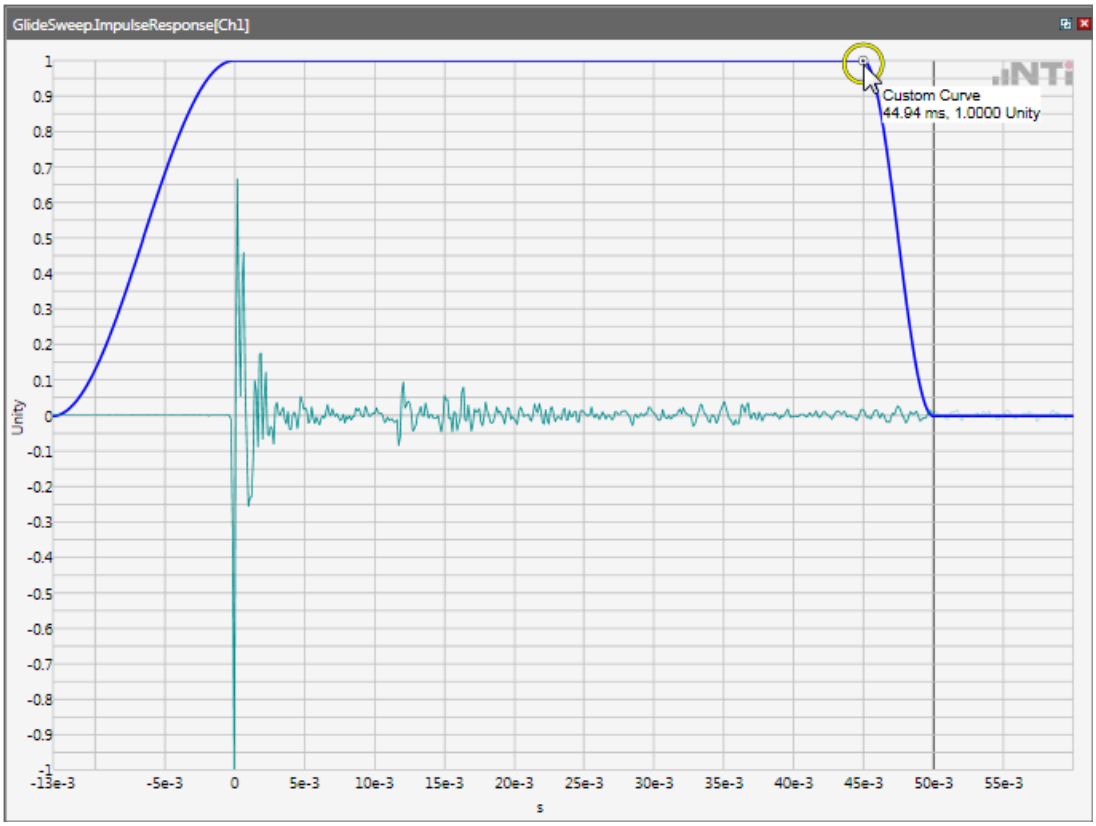
Time window type

The time window implemented on the FX100 is a "Tukey Window 10% Taper"



Time window "Tukey Window 10% Taper"

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Part VI

6 Digital

The branch 'Digital' in the toolbox is only available if the FX-AES board is installed in the FX100. It provides access to the installed digital audio option.

6.1 AES

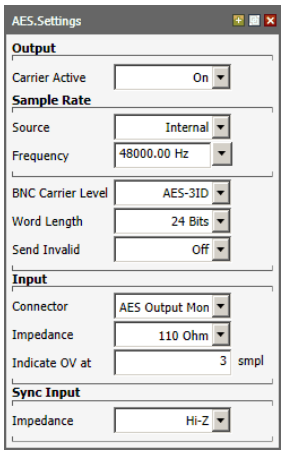
The FX-AES board supports the generation & analysis of digital audio signals according to the AES-3ID standard.

- Settings → basic settings of the digital generator, analyzer
- Carrier status → carrier status, error flags and active bits monitor
- Channel status → channel states of the generator (editable) and analyzer (monitor only)
- Sync status → carrier status of the Sync Ref. Input

Hint ***For more technical details or background information, please refer to the AES-3ID standard http://tech.ebu.ch/docs/tech/tech3250.pdf***

6.1.1 Settings

The AES settings define the physical state of the digital audio signal.



Output

Carrier active On / Off → the digital audio signal is generated / not generated

Sample rate

- Source
  - Internal → the generator clock is created internally
  - AESInputRecovered → the generator synchronizes to the clock of the incoming signal source
  - SyncInput → the generator synchronizes to the clock of the Sync Ref. Input
- Frequency → the sampling rate of the digital audio signal can be adjusted to
  - a standardized frequency (32, 44.1, 48, 88.2, 96, 176.4, 192 kHz) or
  - any user-defined frequency in the range from 28 to 220 kHz
- BNC carrier
  - AES-3ID → the physical signal level (Voltage) of the generator output = 1.2 Vpp
  - SPDIF → the physical signal level (Voltage) of the generator output = 0.6 Vpp
- Word length → selectable 16, 18, 20, 24 bits
- Send invalid Off / On → the status of the generated digital audio signal is valid / invalid

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Input

- Connector
  - XLR → the analyzer is linked to the XLR input connector
  - BNC → the analyzer is linked to the BNC input connector
  - Optical → the analyzer is linked to the TOSLINK input connector
  - AES Output Monitor → the analyzer is internally linked to the generator output
- Impedance
  - 110 Ohm → impedance of input connectors 110 Ω
  - 75 Ohm → impedance of input connectors 75 Ω
  - Hi-Z → impedance of input connectors >10 kΩ
- Indicate OV at x smpl → if an overflow (OV) occurs in the digital audio signal, the active measurement panel(s) will indicate this event as soon as the overflow exceeds the user-defined number of samples

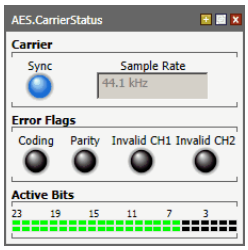
Sync input

Impedance

- Hi-Z → impedance of Sync Ref. Input connector >10 kΩ
- 75 Ohm → impedance of Sync Ref. Input connector 75 Ω

6.1.2 Carrier status

The AES carrier status provides information on the correctness of the digital audio data transmission.



Carrier

- Sync → LED indicates whether the analyzer is synchronized to the input signal
- Sample rate → indicates the detected sampling rate, e.g.
  - standardized frequencies → 32, 44.1, 48, 88.2, 96, 176.4, 193 kHz or
  - customized sampling rate → "No standard SR"

Error flags

- Coding → LED indicates that a bi-phase error has occurred and the data sampled from the biphase stream may not be correct
- Parity → LED illuminates if the digital audio data was received with odd parity, which indicates a potential transmission error
- Invalid CH1/2 → LEDs indicate that the digital audio signal of the corresponding channel is invalid

Active bits

LEDs represent the active bits of the embedded audio signal (e.g. 18 bit)

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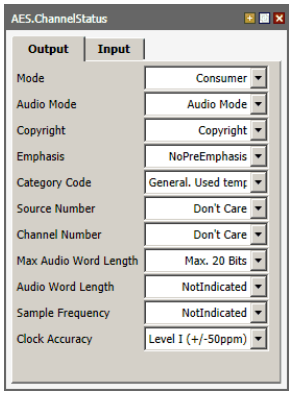
6.1.3 Channel status

The AES channel status carries information associated with the digital audio data.

The FX-AES board allows to

- edit the channel status of the generated signal (settings apply simultaneously on both output channels)
- analyze the channel status of the received signal (independent analysis of the two input channels)



Mode → Consumer or Professional

Consumer mode

- Audio Mode → Audio or Data
- Copyright → active or inactive
- Emphasis → inactive or 50/15µs
- Category code → *list of typical devices*
- Source number → Don't care or #1...15
- Channel number → Don't care or A+B
- Max Audio word length → Max. 20 or 24 bits
- Audio word length → NotIndicated or 16 / 17 / 18 / 19 / 20 bits
- Sample frequency → NotIndicated or 22.05 / 24 / 32 / 44.1 / 48 / 88.2 / 96 / 176.4 / 192 kHz

  Hint ***The indicated sample frequency does not have to match the actual sample rate***
- Clock accuracy → Level I / Level II / Level III / Reserved

Professional mode

- Audio Mode → Normal or NonAudio
- Emphasis
  - NotIndicated
  - None
  - 50/15µs
  - CCITT J-17
- Frequency Mode → Locked or Unlocked
- Sample frequency → NotIndicated or 22.05 / 24 / 32 / 44.1 / 48 / 88.2 / 96 / 176.4 / 192 kHz

Hint ***The indicated sample frequency does not have to match the actual sample rate***

- Scaling → NoScaling or 1 / 1.001
- Channel mode → *list of typical modes*
- User Bits
  - NotIndicated
  - 192-bit clock
  - Reserved
  - User Defined
- Auxiliary Bits
  - Max. 20-bit, not defined
  - Max. 24-bit main audio
  - Max. 20-bit single coord
  - Reserved

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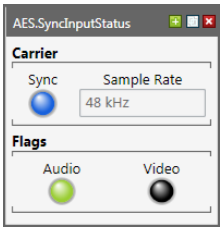
- Audio word length → NotIndicated or 16 / 17 / 18 / 19 / 20 bits
- Reference Signal
  - Not a ref. signal
  - Grade 1
  - Grade 2
  - Reserved
- CRC Valid → Valid or Invalid

6.1.4 Sync input status

The AES sync input status refers to the incoming clock signal of the Sync Ref. Input.



- Carrier
  - Sync → LED illuminates if the FX-AES generator is synchronized to the external clock
  - Sample rate → if the external clock has a standardized sample rate, it is shown here
- Flags
  - Audio → LED illuminates in case of an AES-3ID clock
  - Video → LED illuminates in case of a black-burst video clock (PAL or NTSC)

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Part

7 Regulators, equalization

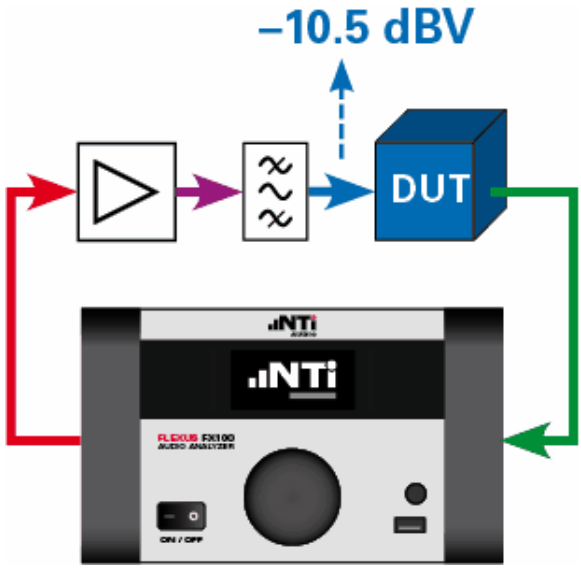
The 'Regulator' is used to execute iterative procedures that optimize specific settings, e.g.

- Generator level → adjusts the FX100 output volume so that the feedback line shows the user-defined level or THD
- GlideSweep range → optimizes the FX100 analyzer input range for the transmitted GlideSweep signal
- Generator equalization → weights the generated test signal so that the feedback line shows a flat frequency response
- Sensitivity calibration → determines the sensitivity [mV/Pa] of a connected microphone

Every regulator application requires a feedback line to the FX100 analyzer.

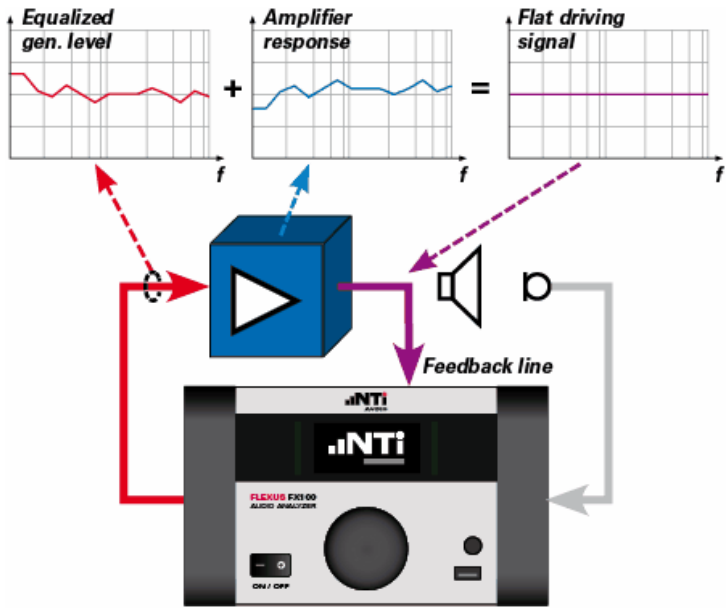
The feedback line can, but does not have to, be identical to the connection between DUT (Device Under Test) and FX100.

Example 1: Generator level



A temporary feedback line to the FX100 analyzer allows adjustment of the generator level so that the driving voltage for the DUT reaches the required level

Example 2: Generator equalization



A temporary feedback line from the amplifier output to the FX100 analyzer input allows equalization of the FX100 generator output signal, whereas the microphone signal is measured in the final application

Hint ***The acquired regulator data can be kept by saving it in a project (together with the current system settings).***

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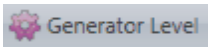
7.1 Generator level

The generator level regulator is used to adjust the FX100 output volume so that either the

- level or
- THD

of the test signal reaches a user-defined value at a specific point in the test setup.

Recommended procedure

1. Establish the test setup and the corresponding Hardware & Wiring schematic.
2. If required, temporarily amend the wiring to regulate the target parameter (*see Example*).
3. Click on 

in the Worksheets ribbon, select the FX100 Device being employed and confirm ("OK") ⇒ the 'Generator Level' panel opens.
4. Adjust the generator & analyzer properties according to the setup and your requirements, e.g.
   - The generator channel to be equalized
   - The Start level and the maximum allowed generator output level for the regulation process
   - The analyzer channel that is used for the feedback measurement
   - The test signal parameter that has to be adjusted (i.e. level or THD)
   - The target value of the aforementioned parameter, as well as its acceptance range
   - The max. number of iterations of the regulation process
5. Make sure that the generator outputs are not muted, start the procedure ('Run') and apply the results ('Apply Level').
6. Re-establish the wiring that is required for device testing.

Hint ***The acquired generator level can be kept by saving it in a project (together with the current system settings).***

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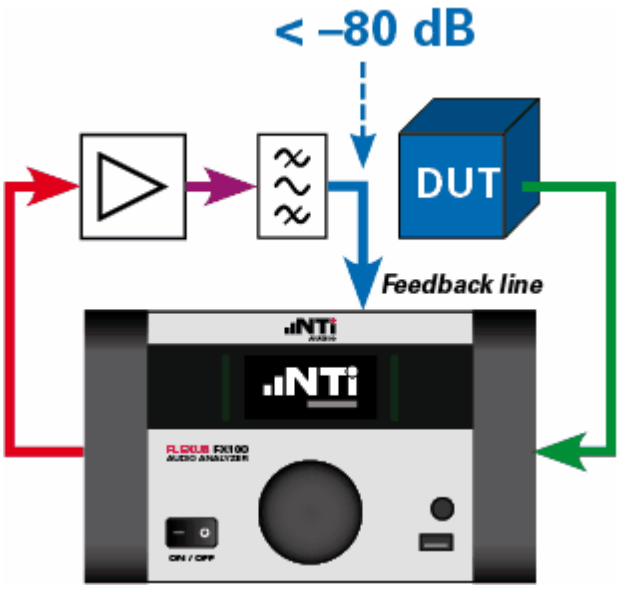
Example

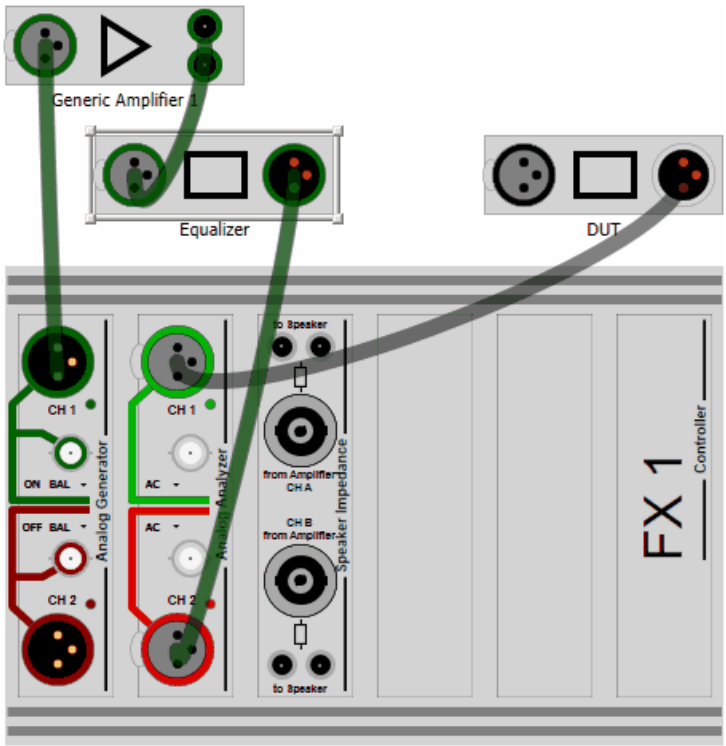
The following example demonstrates how to adjust the FX100 generator voltage so that the THD of the test signal is below -80 dB at the DUT (Device Under Test) input pins.

Step 1



The FX100 generator output volume is adjusted so that the THD of the test signal is below the specified value at the DUT input pins

Step 2



Temporary wiring with feedback line to FX100 analyzer input

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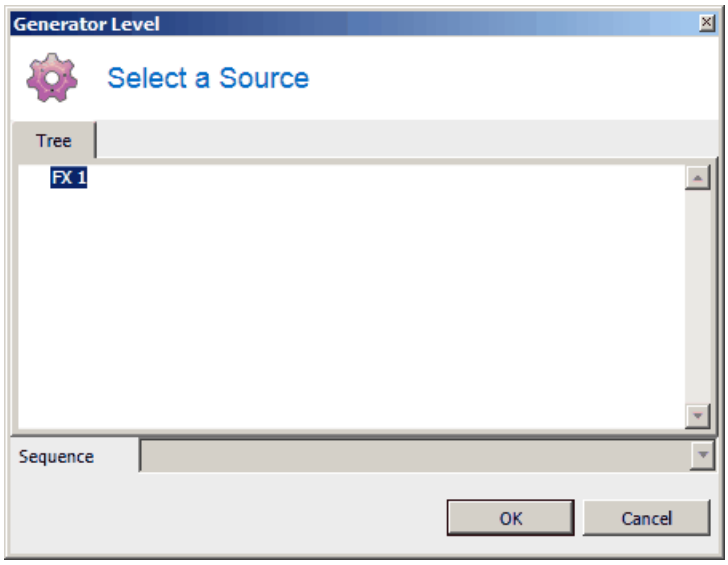
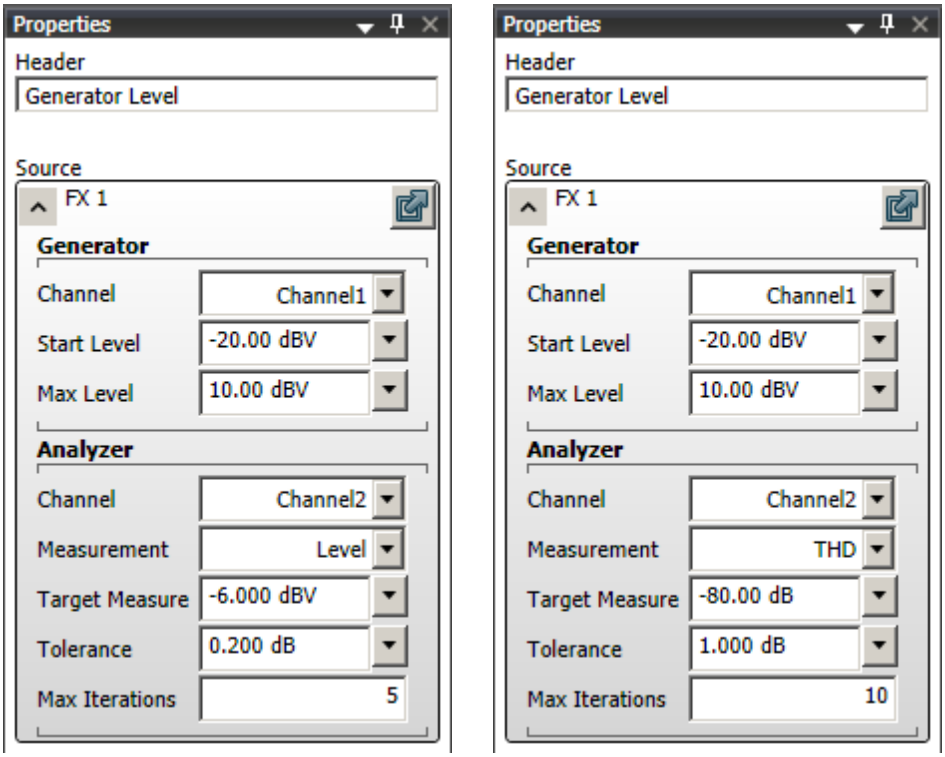
Step 3



Click on the 'Generator Level' button in the Worksheets ribbon, select the FX100 Device being employed and confirm via the 'OK' button

Step 4



Adjust the generator, analyzer properties for generator level regulation

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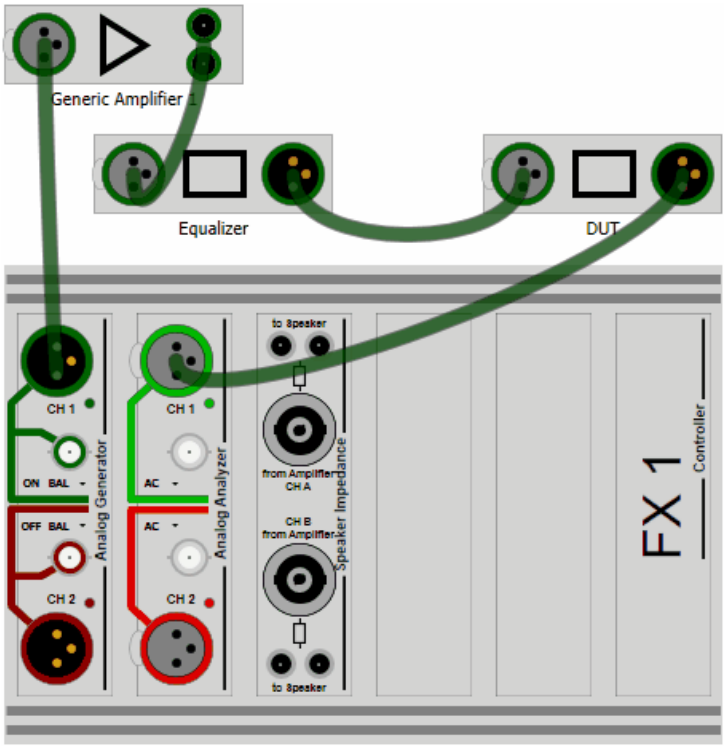
Step 5

Calculated FX100 output level that results in < -80 dB THD at the DUT input pins

Step 6



Required wiring for device testing

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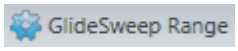
7.2 GlideSweep range

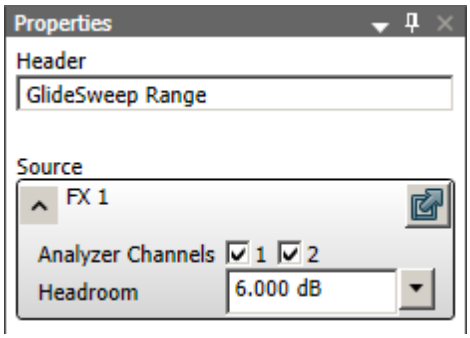
An accurate GlideSweep measurement requires that the input range (i.e. sensitivity) of the FX100 analyzer has been adjusted properly prior to the signal transmission.

For this purpose, FX-Control provides an automated procedure that evaluates the optimum individual input ranges for the analyzer channels.

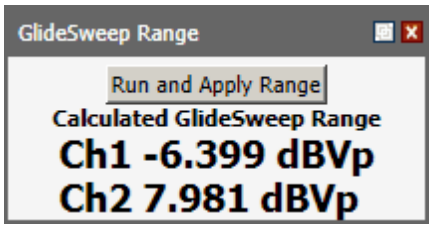
Recommended procedure

1. Establish the test setup and wiring.
2. Adjust the generator GlideSweep properties (e.g. output level, start & stop frequency).
3. Click on the 

button in the Worksheets ribbon, select the FX100 Device being employed and confirm ("OK") ⇒ the 'GlideSweep Range' panel opens.
4. Adjust the regulator properties, i.e.
   - the analyzer channel(s) to be regulated
   - the headroom (i.e. additional "offset" to the minimum required input range)



5. Make sure that the generator outputs are not muted, and start the procedure ('Run and Apply Range').



Hint ***The acquired GlideSweep range can be kept by saving it in a project (together with the current system settings).***

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7.3 Generator equalization

The generator equalization is used to calibrate the FX100 output signal so that it compensates for the characteristics of the downstream device(s).

Hint ***Maximum equalization range is 60 dB***

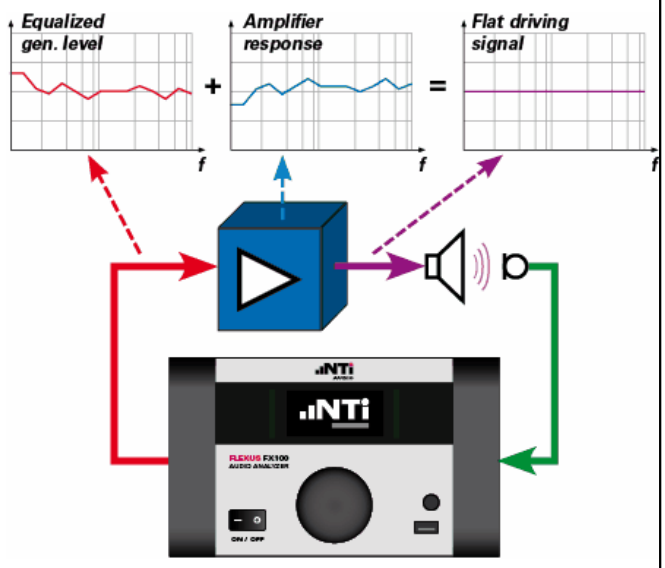
Recommended procedure

1. Establish the test setup and the corresponding Hardware & Wiring schematic.
2. If required, temporarily amend the wiring to allow equalization of the target parameter (*see Example*).
3. Click on Generator Equalization in the Worksheets ribbon, select the FX100 Device being employed and confirm ("OK") ⇒ the 'Generator Equalization' panel opens.
4. Adjust the generator & analyzer properties according to the setup and your equalization requirements, e.g.
   - The generator channel to be equalized
   - StepSweep or GlideSweep parameters, respectively (e.g. spacing, bandwidth, number of points)
   - The Start level and the maximum allowed generator output level for the regulation process
   - The analyzer channel that is used for the feedback measurement
   - Analyzer parameters (e.g. reference frequency & level, acceptance range, max. number of iterations)
   - The sweep mode(s), for which the equalization results are required (*NOTE: GlideSweep equalization data can be applied for StepSweep testing and vice versa*)
5. Make sure that the generator outputs are not muted, start the equalization process ('Run') and apply the results ('Apply').
6. Re-establish the wiring that is required for device testing.

Hint ***The acquired generator equalization data can be kept by saving it in a project (together with the current system settings).***

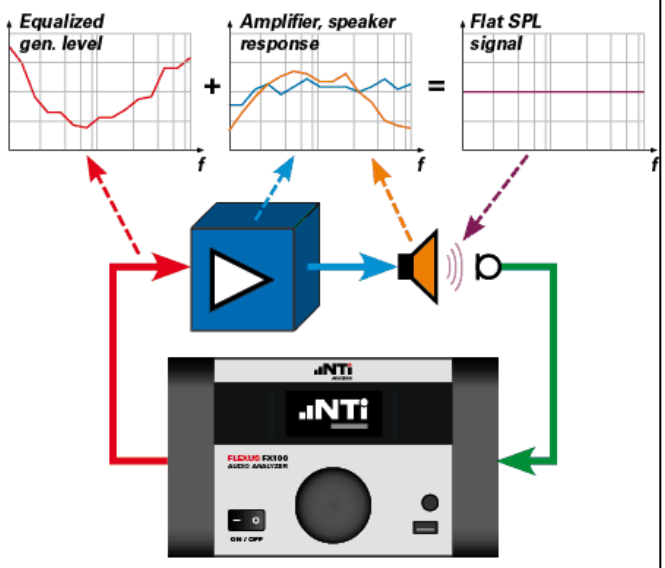
Example

a) Equalization of amplifier output



The FX100 generator output must equalize the amplifier characteristics ⇒ flat frequency response of the speaker driving signal

b) Equalization of speaker output



The FX100 must equalize the amplifier + loudspeaker characteristics ⇒ flat frequency response of the generated sound pressure level

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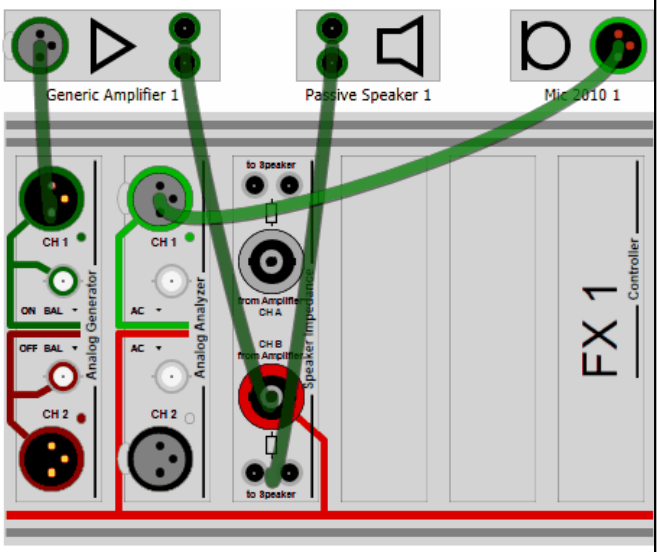
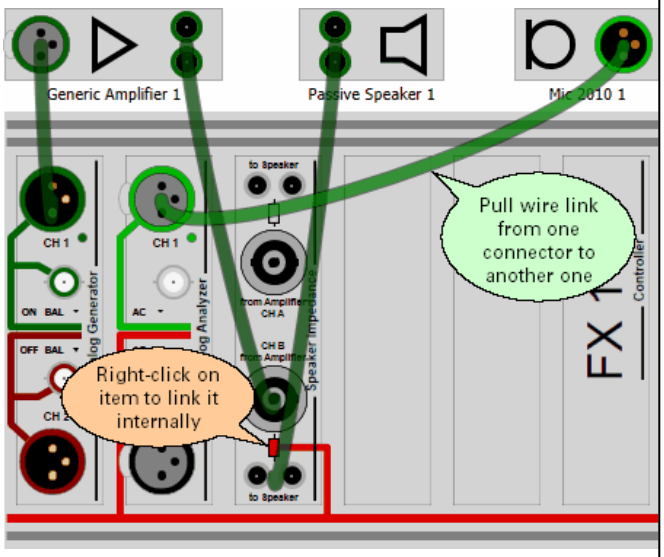
Step 1

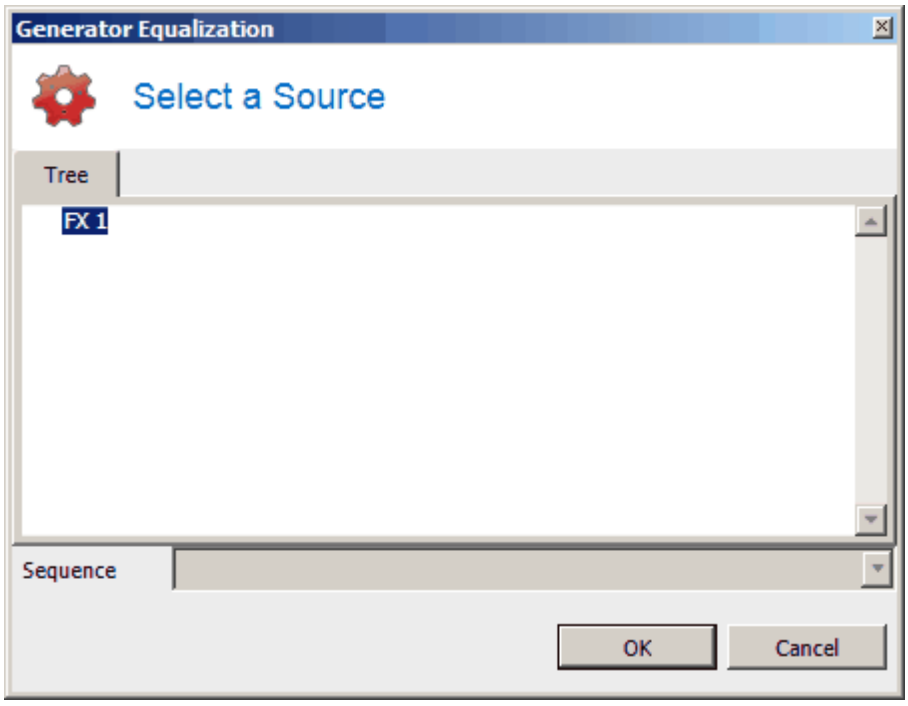


For the amplifier output equalization, the FX-SIL Speakon™ connector must be temporarily linked to analyzer channel 2


Generic Amplifier 1
Passive Speaker 1
Mic 2010 1
Pull wire link from one connector to another one
Right-click on item to link it internally
FX 1

For SPL equalization, the microphone link to analyzer channel 1 is used as feedback line

Step 2



Click on the 'Generator Equalization' button in the Worksheets ribbon, select the FX100 Device being employed and confirm via the 'OK' button

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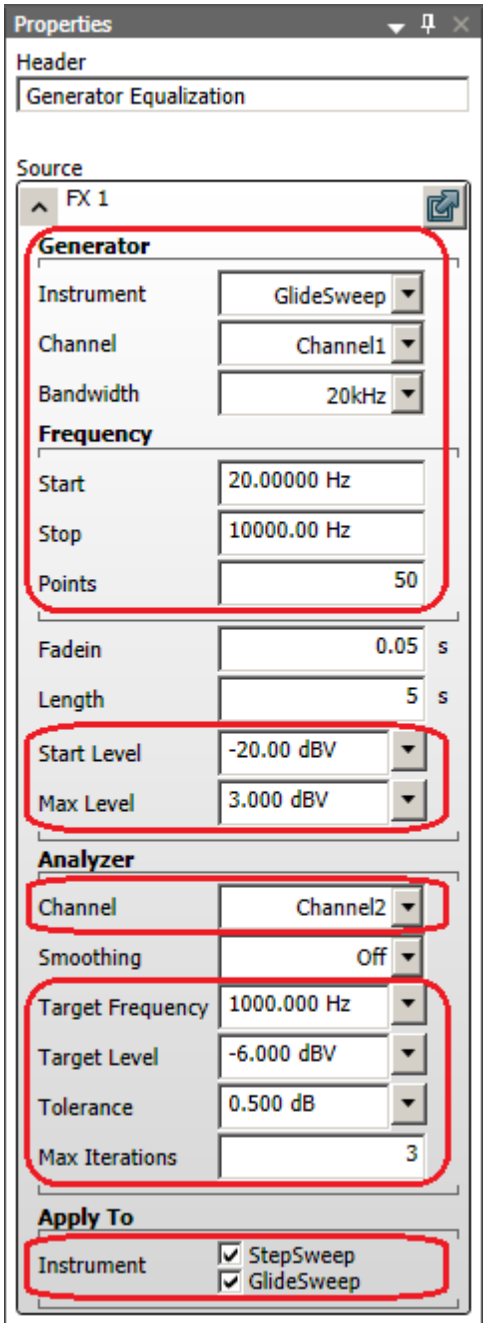
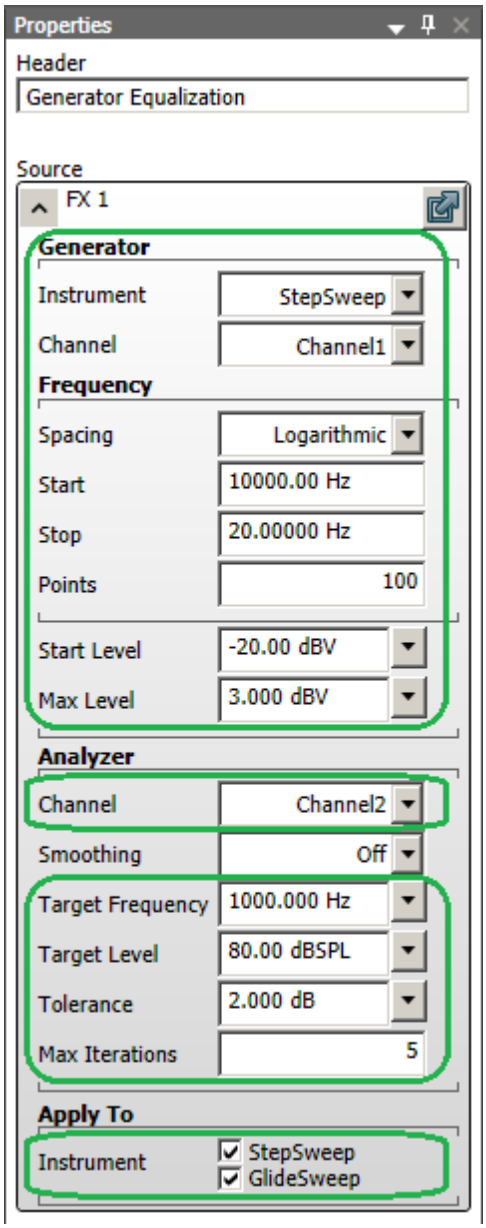
Step 3



Adjust the generator, analyzer properties for amplifier equalization (key parameter settings highlighted)



Adjust the generator, analyzer properties for SPL equalization (key parameter settings highlighted)

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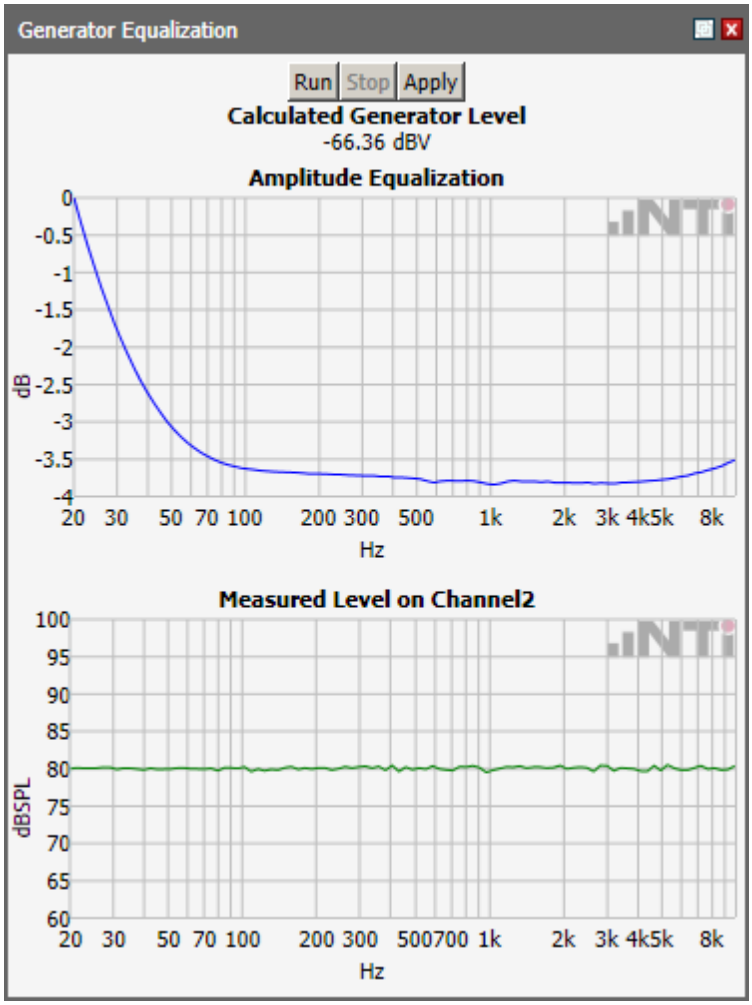
Step 4



Click on the 'Run' button to start the equalization and, if it was completed successfully, on 'Apply'

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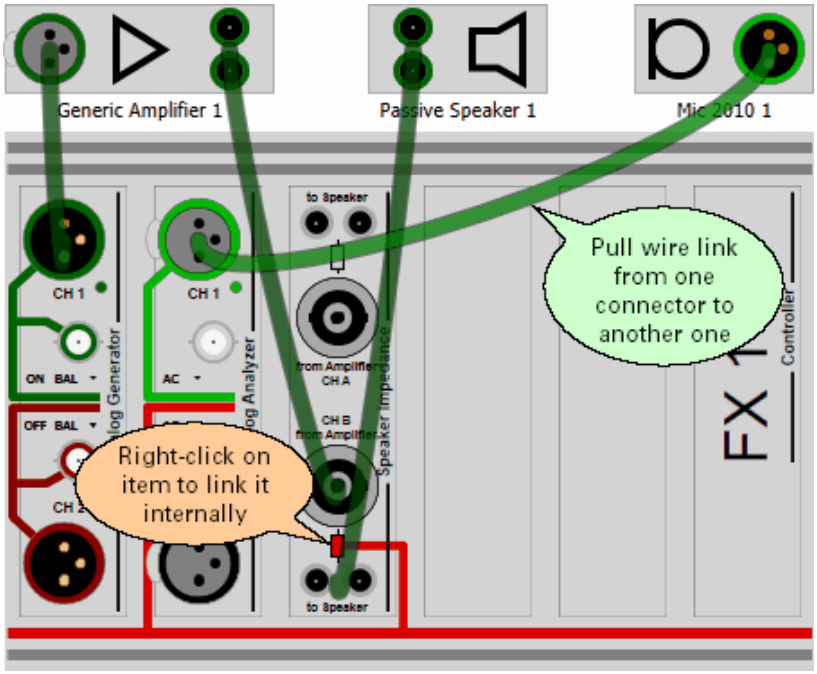
Step 5

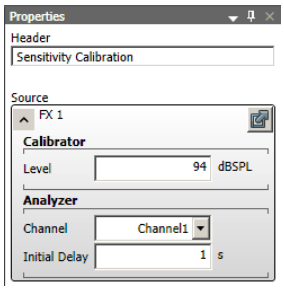


Required wiring for speaker testing

7.4 Sensitivity calibration

The sensitivity calibration allows to measure the exact sensitivity of a connected microphone with the aid of a microphone calibrator.

Recommended procedure



1. Click on Sensitivity Calibration in the Worksheets ribbon, and select the connected FX100 Device.
2. Click on the 'Sensitivity Calibration' panel and adjust its properties, i.e.
   - Level → specified SPL of the microphone calibrator (typically 94 dBSPL)
   - Channel → analyzer input, to which the microphone is connected
   - Initial Delay → user-defined delay that allows the system to settle before the calibration procedure starts
3. Plug the microphone into the mic calibrator and switch ON the calibrator

4. Click on the Run button ⇒ the system displays the acquired sensitivity in [mV/Pa]
5. Click on Apply and close the panel.

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Part VIII

8 Measurements, results, calculations

FX100 supports Meter, StepSweep and GlideSweep measurements in three operating modes.

i. Single shot, i.e. singular acquisition of the active measurements of all operating modes

ii. Repeat, i.e. cyclic execution of the active measurements of all operating modes

iii. Continuous, i.e. permanent execution of the selected measurement only

Preparations

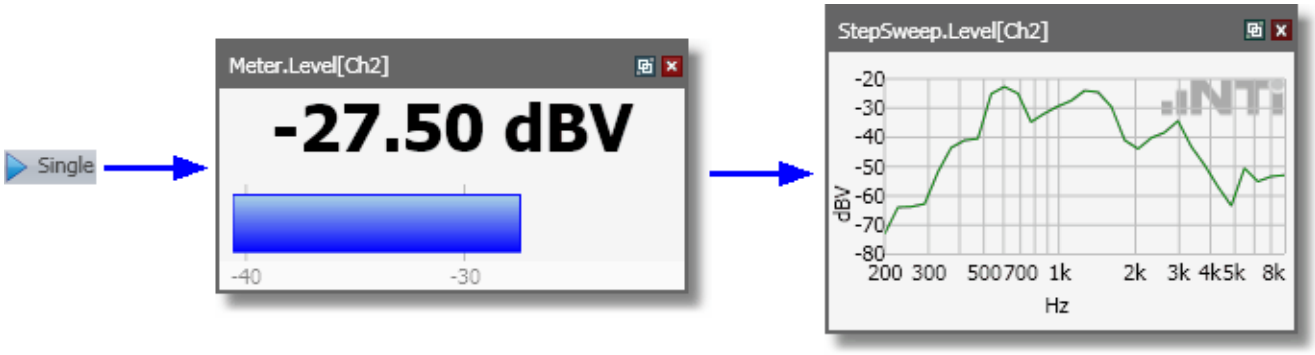
1. Adjust the generator settings (i.e. test signal parameters).
2. Adjust the analyzer settings (e.g. synchronization, range, coupling).
3. Activate the required measurement(s) in the Worksheets, i.e. either
   - drag & drop it from the toolbox to the worksheet, or
   - right-click on the measurement icon in the toolbox and select the display type, or
   - left-click on the related button in the worksheets ribbon and select the measurement function.

NOTE A measurement is only executed if a corresponding result display is placed on a Worksheet.

Single shot

Click on the Single button in the 'Start' ribbon to initiate the single shot sequential execution of the active measurement functions.

Example: Meter & StepSweep level

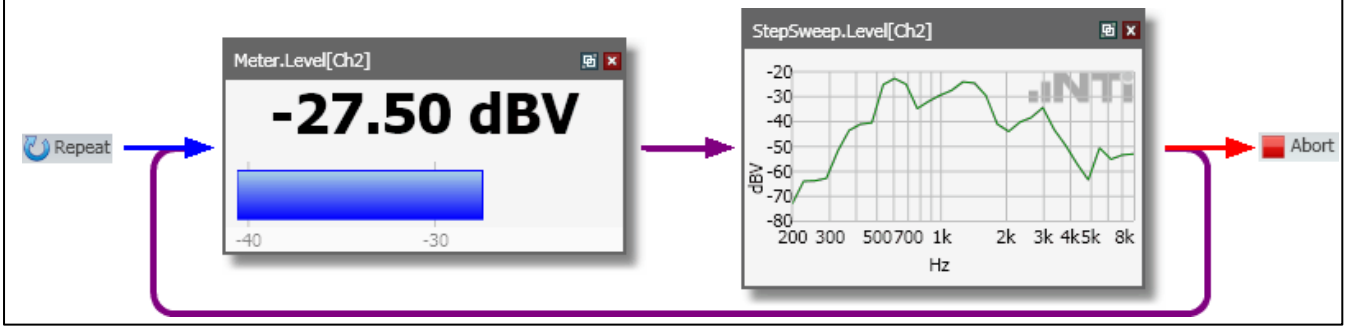


NOTE The blue 'Single' and 'Repeat' buttons refer to the corresponding FX100 instument only, whereas the green 'All Single' and 'All Repeat' buttons apply on all connected FX100 Devices.

Repeat

Click on the Repeat button in the 'Start' ribbon to initiate the repeated consecutive execution of the active measurement functions.

Example: Meter & StepSweep level



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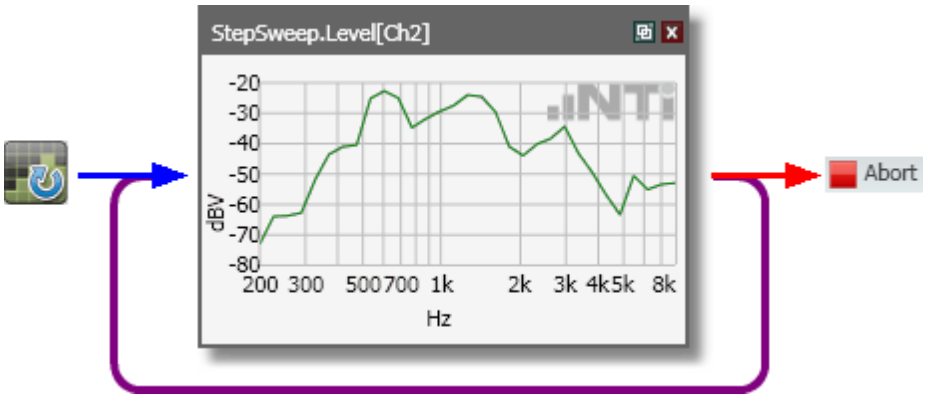
Continuous

Click on the , or button in the 'Start' ribbon to initiate the continuous acquisition of the respective measurements.

Example: StepSweep level



Hint ***Result display*** ***and*** ***calculations*** ***are described in the corresponding chapters.***

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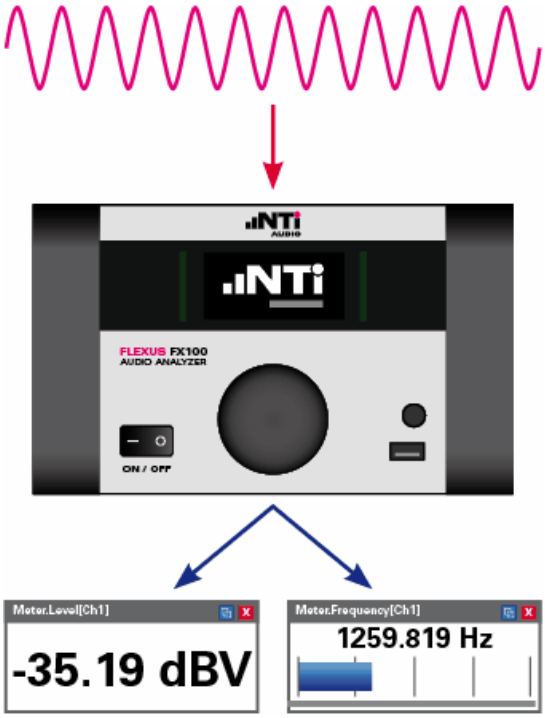
8.1 Meter

In the Meter mode, the FX100 analyzes the incoming signal and shows the single-value measurement results numerically or in a bargraph.

- Both the analysis of internally or externally generated test signals is supported
- The test signal parameters (generator settings) may be amended during the measurement.
- The analyzer ranging can be adjusted automatically or manually.
- The Meter mode is typically used for single-value measurements (e.g. frequency, level, THD) or monitoring applications.

Measurements



- Frequency
- Level
- Input level
- Selective level
- FFT
- Gain
- THD
- THD+N
- Harmonics
- Phase
- XTalk
- PureSound
- DCV
- DCV common high
- DCV common low
- DCR
- Speaker Impedance

Settling

FX100 applies an automated settling procedure to ensure that the acquired measurement results are stable and relevant.

Some static and dynamic parameters of this procedure can be edited manually if required.

NOTE Be very careful if you edit the settling parameters. Inappropriate settings can prolong test cycle time or even inhibit the acquisition of valid measurement results.

In case of continuous Meter measurements, the settling is not active

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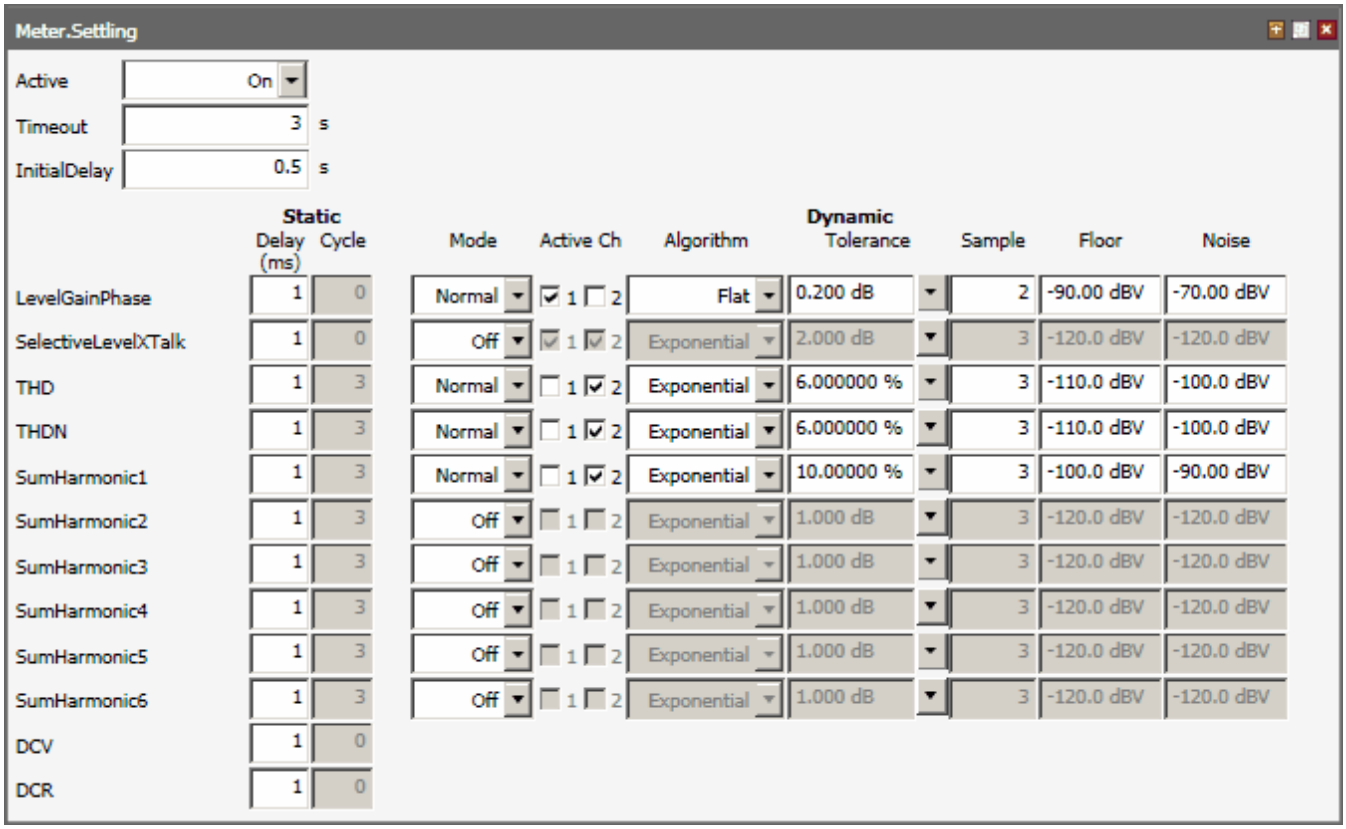
Meter.Settling
Active On
Timeout 3 s
InitialDelay 0.5 s
Static
Dynamic
Delay (ms) Cycle Mode Active Ch Algorithm Tolerance Sample Floor Noise
LevelGainPhase 1 0 Normal 1 2 Flat 0.200 dB 2 -90.00 dBV -70.00 dBV
SelectiveLevelXTalk 1 0 Off 1 2 Exponential 2.000 dB 3 -120.0 dBV -120.0 dBV
THD 1 3 Normal 1 2 Exponential 6.000000 % 3 -110.0 dBV -100.0 dBV
THDN 1 3 Normal 1 2 Exponential 6.000000 % 3 -110.0 dBV -100.0 dBV
SumHarmonic1 1 3 Normal 1 2 Exponential 10.00000 % 3 -100.0 dBV -90.00 dBV
SumHarmonic2 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV
SumHarmonic3 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV
SumHarmonic4 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV
SumHarmonic5 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV
SumHarmonic6 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV
DCV 1 0
DCR 1 0

Meter settling properties

Meter settling properties (please refer also to the Example below)

- Active → overall activation of the settling for all measurement functions
- Timeout [s] → maximum allowed settling duration; if the timeout expires without successful settling ⇒ no valid measurement result
- Initial Delay [s] → one-time delay before the settling process starts
- Delay [ms] → idle time before the settling process starts
- Cycle (*not editable*) → number of signal periods that have to pass by before the settling process starts
- Mode → individual (de-)activation of the settling for the specific measurement function(s)
  - Normal → settling is active
  - Off → settling is deactivated
- Active Ch → activate or deactivate the settling for a specific channel
- Algorithm → select the settling method
  - Exponential → the tolerance band gets wider as more samples are acquired
  - Flat → the width of the tolerance band is fixed (i.e. identical limits for all acquired samples)
- Tolerance → the acceptable headroom (expressed in dB or %) between the last acquired sample and the upper, lower tolerance limit
- Sample → the number of samples that must be within the tolerance limits to fulfill the settling condition.
- Floor → minimum signal level that a sample must have to be considered for the settling process
- Noise → the inherent noise of the connected device(s) or analyzer is added to the acquired result, thus widening the acceptance criterion

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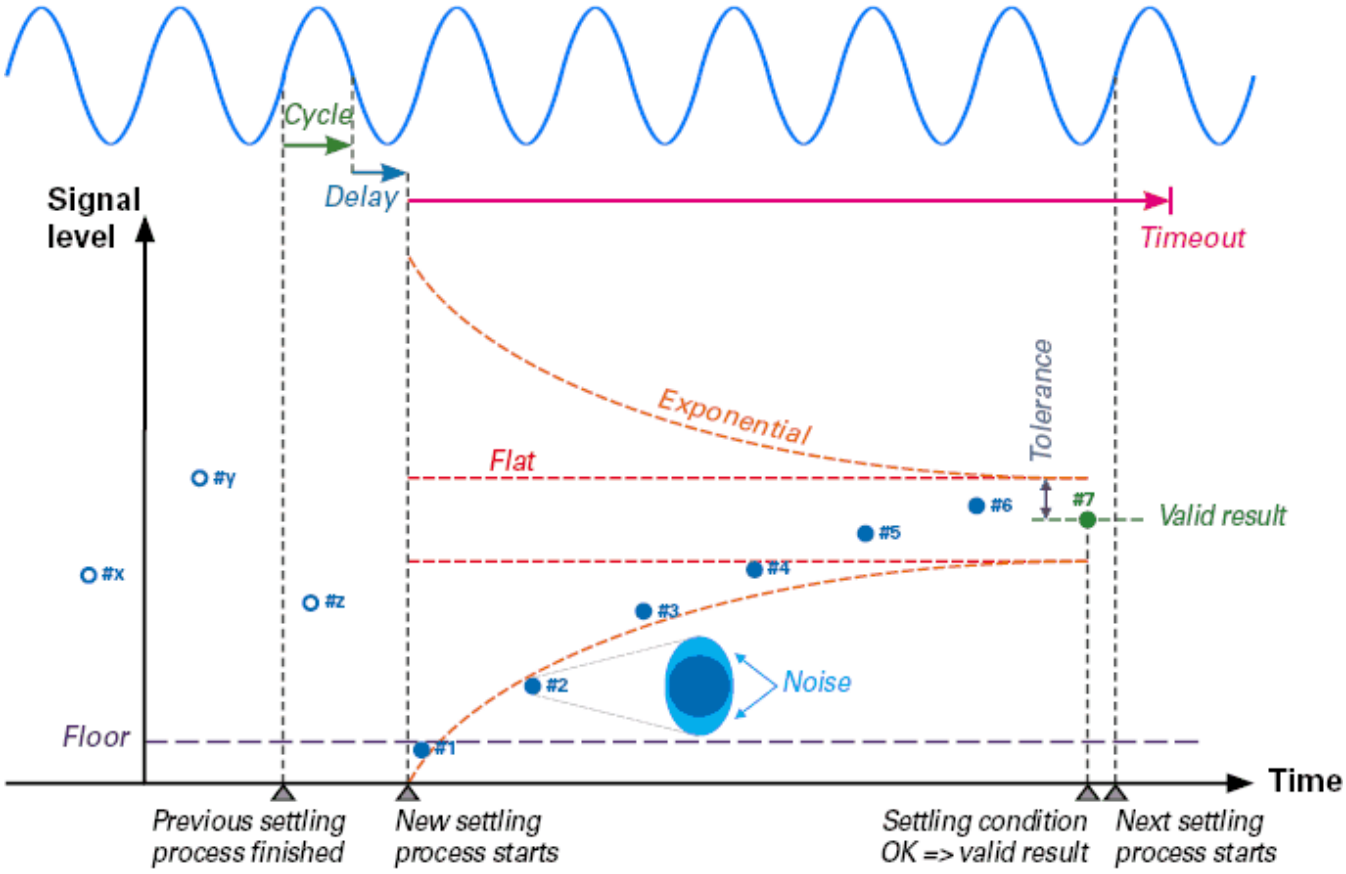
Example



Settling procedure

Sample	*Comments*
#x, #y, #z	samples are not considered for the current settling process, as they were acquired before the expiration of Cycle, Delay
#1	sample rejected since it is below the Floor level (though it would meet the Exponential limit)
#2	sample rejected since it meets neither Exponential nor Flat tolerance limits
#3, #4	samples within Exponential, but not Flat limits
#5, #6	samples meet both Exponential and Flat limits (*NOTE: only one limit type applies in practice*)
#7	valid sample = measurement result, since the current settling conditions are met

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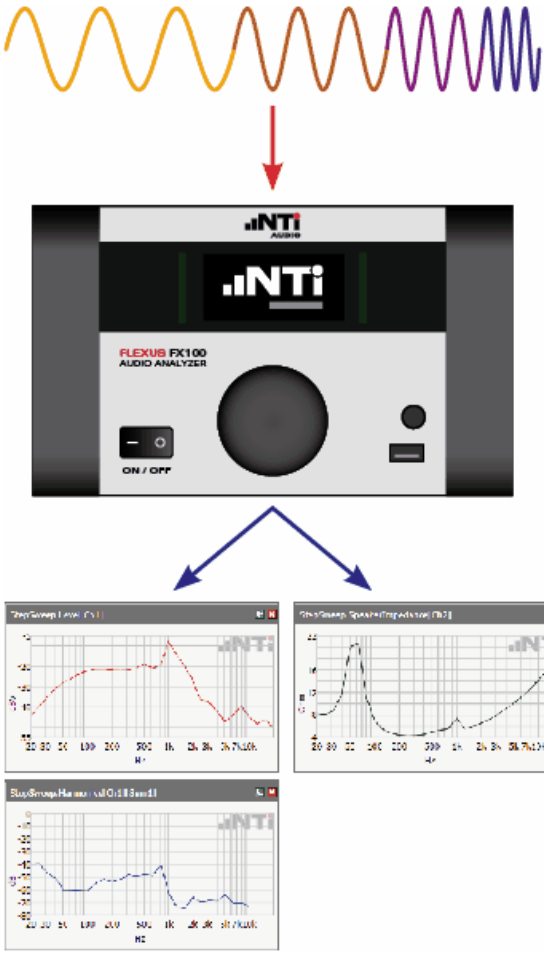
8.2 StepSweep

FX100 StepSweep analysis supports several audio measurements (Y-axis) versus three different parameters (X-Axis).

- Test signal parameters (generator settings) must be defined prior to the measurement and can not be amended during the sweep.
- Ranging can be adjusted automatically or manually.

The key advantage of StepSweep measurements is a high signal-to-noise ratio, thus providing highly accurate test results.

NOTE If a noise level shall be measured, the analyzer synchronization must be switched to 'Generator' and the acquisition to 'Wideband'.



StepSweep modes

a) Frequency

b) Amplitude

c) Time

d) Table

NOTE Special attention must be paid to the correct synchronization between FX100 analyzer and the signal generator

Measurements

- Level
- Selective level
- Gain
- THD
- THD+N
- Harmonics
- Phase
- XTalk
- Speaker Impedance

Settling

FX100 applies an automated settling procedure to ensure that the acquired measurement results are stable and relevant.

Some static and dynamic parameters of this procedure can be edited manually if required.

NOTE Be very careful if you edit the settling parameters. Inappropriate settings can prolong test cycle time or even inhibit the acquisition of valid measurement results.

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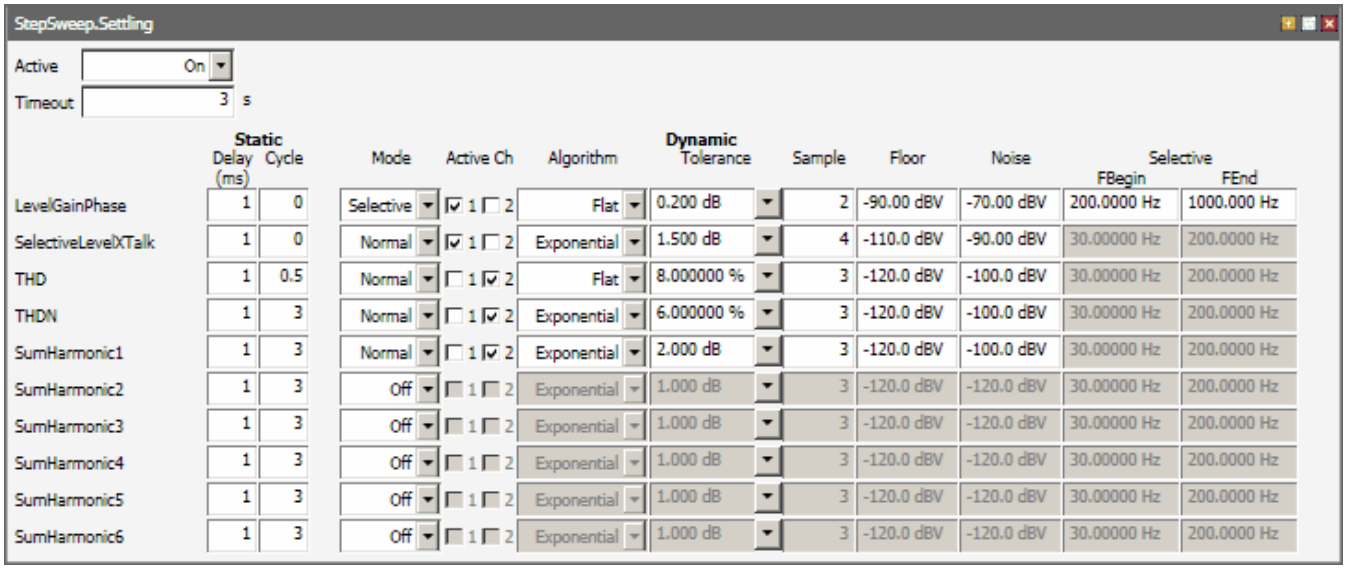
StepSweep.Settling
Active
On
Timeout
3
s
Static
Delay (ms)
Cycle
Mode
Active Ch
Algorithm
Dynamic
Tolerance
Sample
Floor
Noise
Selective
FBegin
FEnd
LevelGainPhase 1 0 Selective 1 2 Flat 0.200 dB 2 -90.00 dBV -70.00 dBV 200.0000 Hz 1000.000 Hz
SelectiveLevelXTalk 1 0 Normal 1 2 Exponential 1.500 dB 4 -110.0 dBV -90.00 dBV 30.00000 Hz 200.0000 Hz
THD 1 0.5 Normal 1 2 Flat 8.000000 % 3 -120.0 dBV -100.0 dBV 30.00000 Hz 200.0000 Hz
THDN 1 3 Normal 1 2 Exponential 6.000000 % 3 -120.0 dBV -100.0 dBV 30.00000 Hz 200.0000 Hz
SumHarmonic1 1 3 Normal 1 2 Exponential 2.000 dB 3 -120.0 dBV -100.0 dBV 30.00000 Hz 200.0000 Hz
SumHarmonic2 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV 30.00000 Hz 200.0000 Hz
SumHarmonic3 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV 30.00000 Hz 200.0000 Hz
SumHarmonic4 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV 30.00000 Hz 200.0000 Hz
SumHarmonic5 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV 30.00000 Hz 200.0000 Hz
SumHarmonic6 1 3 Off 1 2 Exponential 1.000 dB 3 -120.0 dBV -120.0 dBV 30.00000 Hz 200.0000 Hz

StepSweep settling properties

StepSweep settling properties (please refer also to the Example below)

- Active → overall activation of the settling for all measurement functions
- Timeout [s] → maximum allowed settling duration; if the timeout expires without successful settling ⇒ no valid measurement result
- Delay [ms] → idle time before the settling process starts
- Cycle (*not editable*) → number of signal periods that have to pass by before the settling process starts
- Mode → individual (de-)activation of the settling for the specific measurement function(s)
  - Normal → settling is active
  - Selective → settling is only active in the user-defined frequency range
  - Off → settling is deactivated
- Active Ch → activate or deactivate the settling for a specific channel
- Algorithm → select the settling method
  - Exponential → the tolerance band gets the wider, the longer ago a sample has been acquired
  - Flat → the width of the tolerance band is fixed (i.e. identical limits for all acquired samples)
- Tolerance → the acceptance headroom (expressed in dB or %) between the last acquired sample and the upper, lower tolerance limit
- Sample → the number of samples that must be within the tolerance limits to fulfill the settling condition.
- Floor → minimum signal level that a sample must have to be considered for the settling process
- Noise → the inherent noise of the connected device(s) or analyzer is added to the acquired result, thus widening the acceptance criterion

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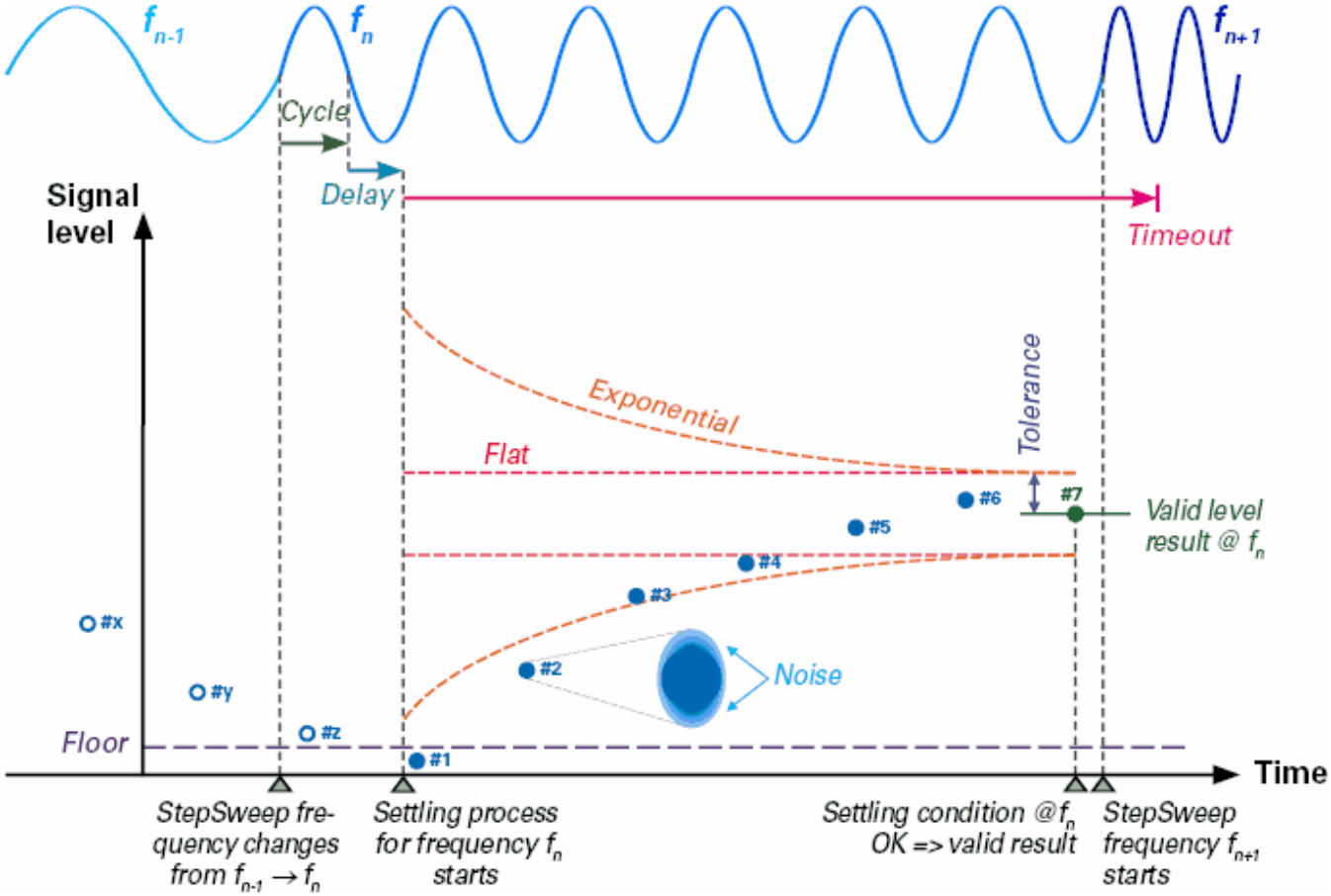
Example



Settling procedure

Sample	*Comments*
#x, #y, #z	samples are not considered for the current settling process, as they were acquired before the expiration of Cycle, Delay
#1	sample rejected since it is below the Floor level
#2	sample rejected since it meets neither Exponential nor Flat tolerance limits
#3, #4	samples within Exponential, but not Flat limits
#5, #6	samples meet both Exponential and Flat limits (*NOTE: only one limit type applies in practice*)
#7	valid sample = measurement result, since the current settling conditions are met

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8.3 GlideSweep

In GlideSweep mode, the FX100 samples the incoming chirp and then calculates the measurement results.

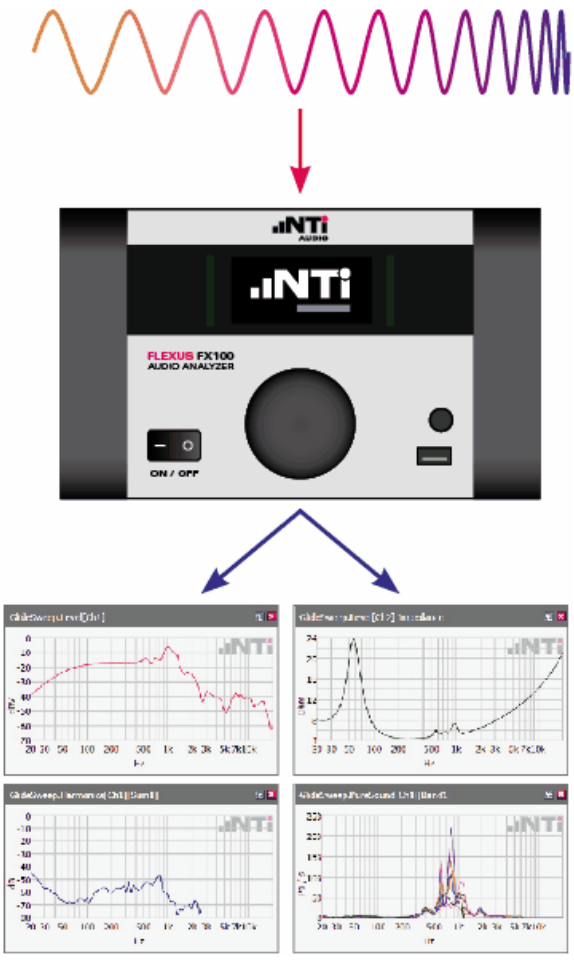
The following preparations are required to execute a GlideSweep ('chirp') measurement:

- Definition of test signal parameters (generator settings; these settings can not be amended during the sweep).
- Proper adjustment of the analyzer input range.

The key advantage of GlideSweep analysis is the short test cycle time, which makes this method very attractive for high-volume production applications. Furthermore, PureSound steepness analysis is an extremely powerful measure for detecting audible imperfections.

On the other hand, GlideSweep measuring accuracy decreases with very short sweep durations.

NOTE The analyzer GlideSweep range must be adjusted properly prior to the signal transmission & measurement.



GlideSweep modes

a) Logarithmic

b) Linear (*this mode supports only PureSound measurements*)

NOTE PureSound analysis results that have been acquired with a logarithmic GlideSweep are not 100% compatible to the data from a linear GlideSweep

Measurements

- Level
- THD
- Harmonics
- PureSound
- Phase
- Speaker impedance
- Signal latency
- Impulse response
- ETC

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8.4 Measurement functions

The following matrix shows the measurement functions supported by FX100, and the operating modes in which they are available.

NOTE A measurement is only executed if a result display is placed on a Worksheet.

Measurement function	*Comment*	*Meter*	*StepSweep*	*GlideSweep*
Frequency	dominant frequency of the input signal	✓		
Level	AC-coupled wideband level after filtering	✓	✓	✓
InputLevel	DC-coupled unfiltered level	✓		
SelectiveLevel	bandpass-filtered level	✓	✓	
FFT	signal spectrum (Fast Fourier Transformation)	✓		
Gain	ratio of input vs. output level	✓	✓	
THD	Total Harmonic Distortion [1)]	✓	✓	✓
THD+N	Total Harmonic Distortion + Noise [1)]	✓	✓	✓
Harmonics	upper harmonics	✓	✓	✓
Phase	interchannel phase	✓	✓	✓
XTalk	interchannel crosstalk	✓	✓	
PureSound	transient steepness [2)]	✓		✓
DCV	Differential DC voltage (between XLR pin 2 and 3)	✓		
DCVCommonLow	DC voltage between XLR pin 3 and GND	✓		
DCVCommonHigh	DC voltage between XLR pin 2 and GND	✓		
DCR	DC resistance	✓		
SpeakerImpedance [3)]	impedance of the connected speaker	✓	✓	✓
Signal latency [4)]	propagation time of a GlideSweep			✓
ImpulseResponse	impulse response			✓
ETC	Energy-Time Curve			✓
AESInputSampleRate [5)]	clock frequency of the AES input signal	✓		
SyncInputSampleRate [5)]	clock frequency at the Sync Ref Input connector	✓		

[1)] Please refer to chapter THD calculation method

[2)] PureSound analysis results from a logarithmic GlideSweep may vary from those of a linear GlideSweep

[3)] Only available if a SIL or SIH option is installed ($R_{Speaker} = U_{Speaker} / U_{Shunt}$)

[4)] Only available for external GlideSweep transmission

[5)] Only available if FX-AES board is installed

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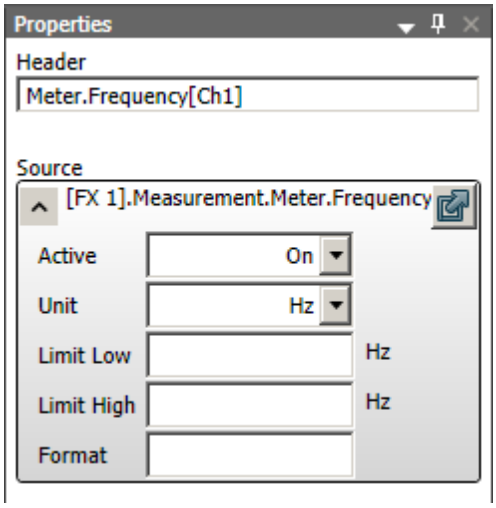
8.4.1 Frequency

The frequency measurement detects & analyzes the frequency of the dominant input signal component (Meter mode only).

Properties



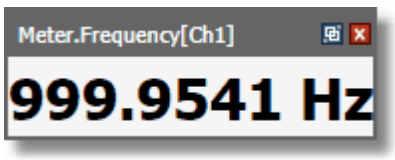
- Header → editable name of the numerical frequency measurement display
- Source → measurement function; if it shall be amended, click on the button.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit
  - Hz → Hertz
  - ppmr → deviation in ppm relative to the current reference frequency
- Limit(s)
  - Low → optionally enter the lower tolerance limit of the frequency measurement
  - High → optionally enter the upper tolerance limit of the frequency measurement

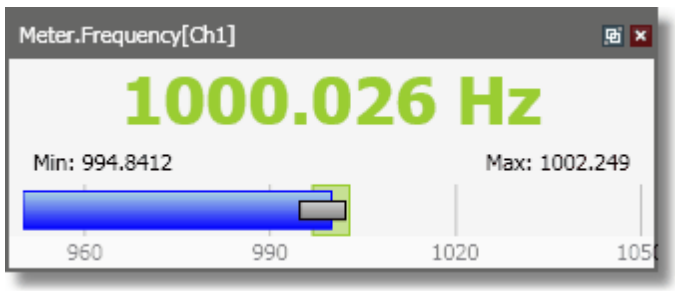
Hint ***It is possible to enter no limit, only the upper or the lower limit, or both limits***

- Format → the format in which the numerical results are displayed.

Result display

The frequency measurement results can be displayed either as a numerical value or in a bargraph.





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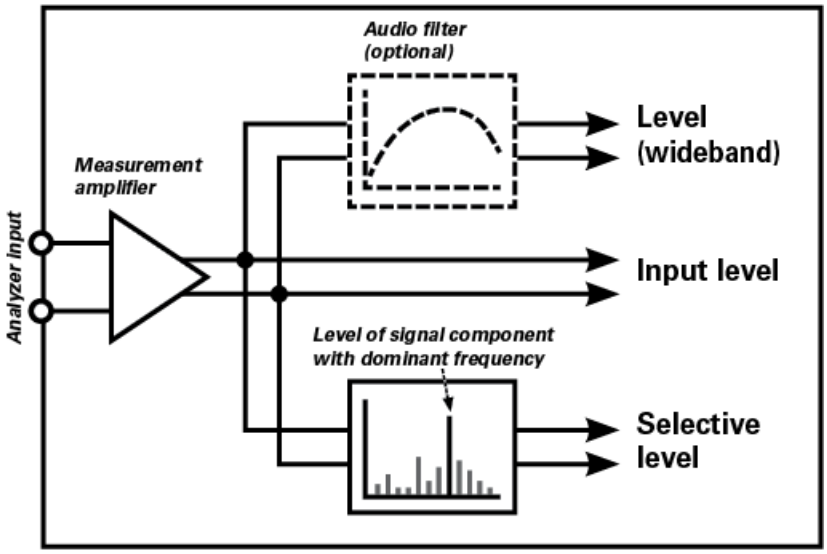
8.4.2 Level, input level, selective level

FX100 supports three different level measuring methods.



A) Level (wideband)

The level of the incoming signal after the input audio filter.

(*available in Meter, StepSweep or GlideSweep mode*)

B) Input level

The level of the incoming signal 'as is', i.e. without any audio filter.

(*available only in Meter mode*)

C) Selective level

The amplitude of the signal component with the dominant frequency

(*available in Meter or StepSweep mode*)

Hint ***If no audio filter is active, the wideband level = input level***

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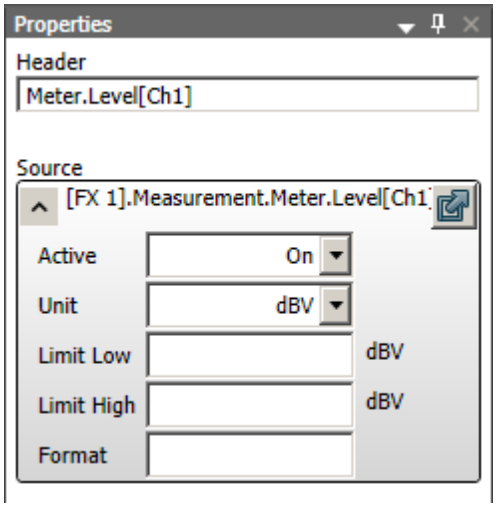
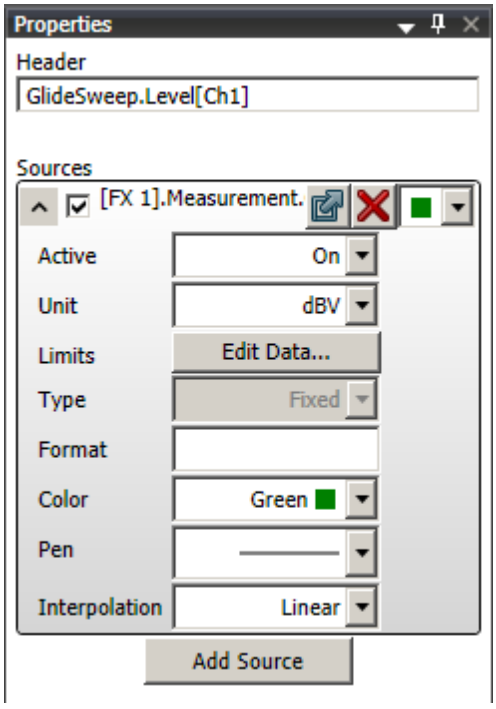
Properties





- Header → editable name of the level measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit → the measurement unit in which the measured level shall be expressed
  - V
  - dBV
  - dBPa
  - dBSPL
  - dBu
  - dBr

Hint ***With the dBr measurement you can compare the input signal to a user-defined reference level.***

- Limit(s)
  - Low (*Meter mode*) → optionally enter the lower tolerance limit of the measurement
  - High (*Meter mode*) → optionally enter the upper tolerance limit of the measurement
  - Edit Data... (*Sweep mode*) → optionally edit the tolerance limits of the measurement

Hint ***It is possible to enter no limit, only the upper or the lower limit, or both limits***

- Type → *not yet implemented* (absolute or floating tolerance limits)
- Format → the format in which the numerical results are displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.

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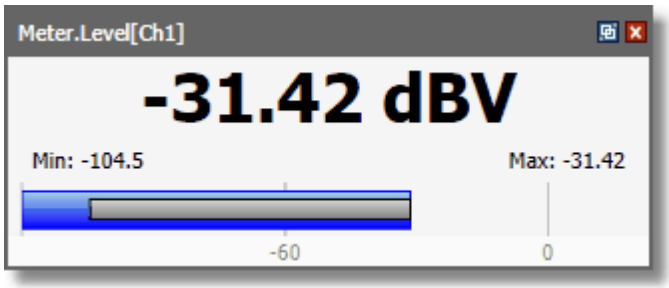
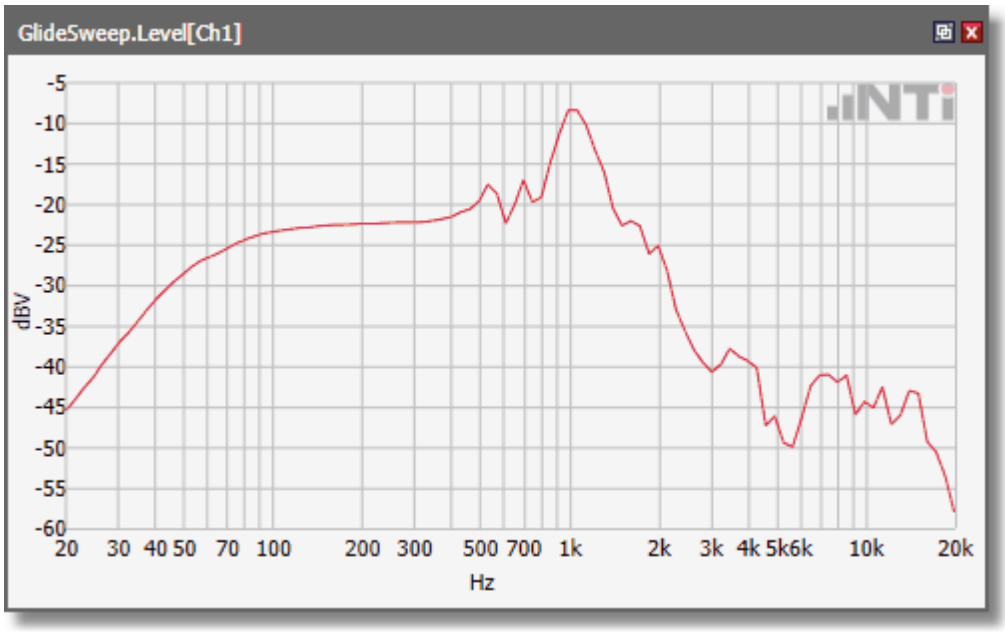
The level measurement results can be displayed either

- as numerical value (Meter mode)
- in a bargraph (Meter mode)
- in a graph (StepSweep or GlideSweep mode)





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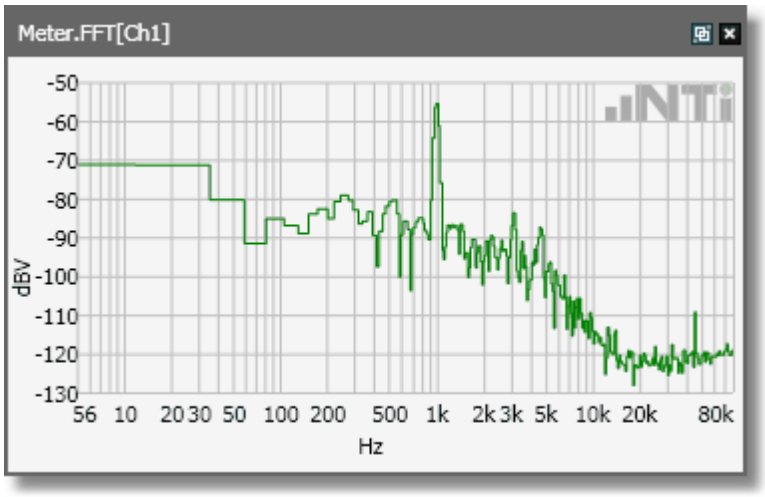
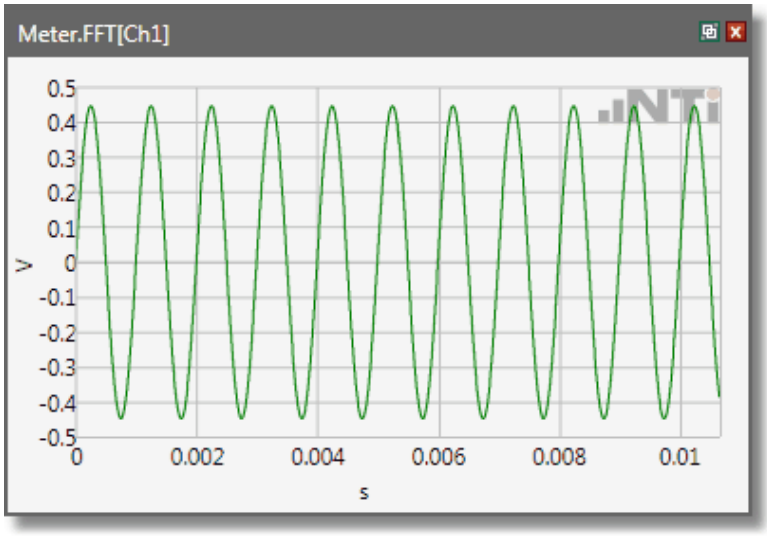
8.4.3 FFT

The FFT, scope measurements are only available in the Meter mode.

A) Spectrum analysis (frequency domain)



B) Scope mode (time domain)



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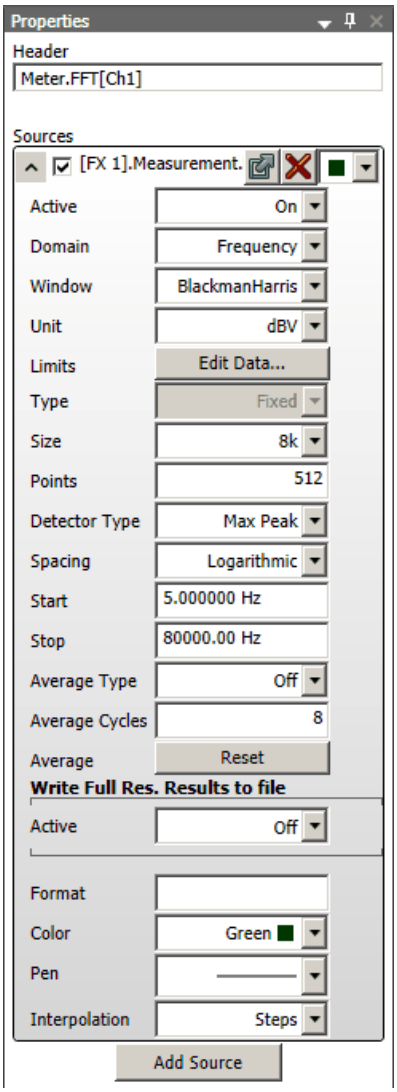

- Header → editable name of the FFT measurement display
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Domain
  - Frequency → spectral signal analysis
  - Time → time signal analysis ('scope' mode)
- Trigger → the start of the signal acquisition can be triggered (*only available in Time domain mode)*
  - Active → On or Off
  - Channel → select the input channel that is used for triggering
- Window → the
  - BlackmanHarris
  - Hann
- Unit → the measurement unit in which the FFT level shall be expressed
  - V
  - dBV
  - dBPa
  - dBSPL
  - dBu
- Limits: Edit Data... → click on this button to edit the tolerance limit of the FFT measurement
- Type → *not yet implemented* (absolute or floating tolerance limits)
- Size → the length (i.e. #samples or blocklength) of the FFT calculation gives the frequency resolution (*see Example 1 below*).
  - 512 ⇒ 375 Hz
  - 1024 ⇒ 187.5 Hz
  - 2048 ⇒ 93.75 Hz
  - 4096 ⇒ 46.88 Hz
  - 8192 ⇒ 23.44 Hz
  - 16384 ⇒ 11.72 Hz
  - 32768 ⇒ 5.86 Hz
  - 65536 ⇒ 2.93 Hz
  - 131072 ⇒ 1.46 Hz
  - 262144 ⇒ 0.73 Hz
  - 524288 ⇒ 0.37 Hz
  - 1048576 ⇒ 0.18 Hz
  - 2097152 ⇒ 0.09 Hz
- Points → number of calculated & displayed FFT points between the start, stop frequency (less points ⇒ shorter data transfer).
- Detector Type → the result curve represents... (*see Example 2 below*)
  - Max Peak (recommended for display) → ...the maximum FFT *bin value* is searched and returned within the width of one and the next graph points.
  - Power (recommended for calculations) → ...the *energy* within the width of one and the next graph points.
- Spacing → linear or logarithmic distribution of the level results on the X-axis
- Start → lower end of the displayed frequency range (*side note: the FFT is always calculated over the full 80 kHz bandwidth*)
- Stop → upper end of the displayed frequency range

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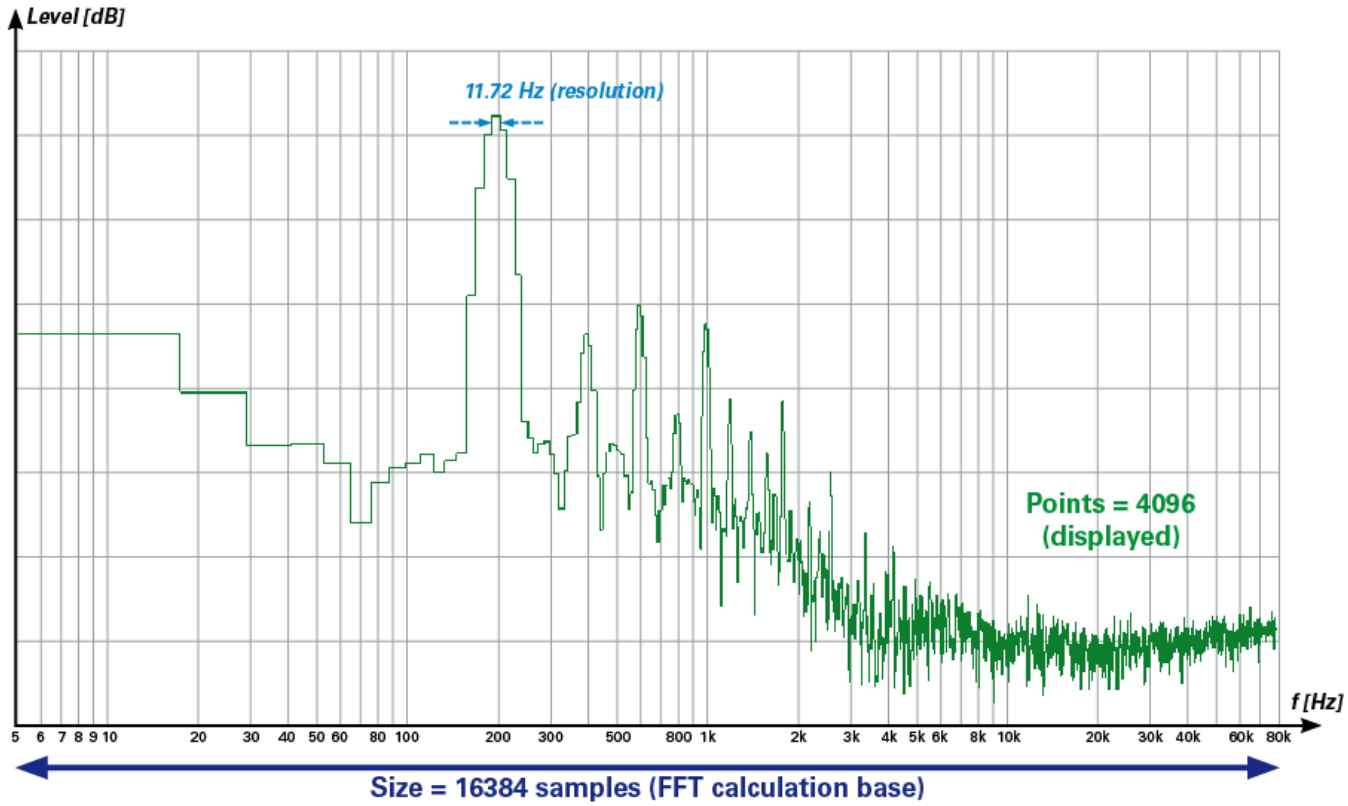
- Average Type → for averaging of several consecutive FFT spectra
  - Off → averaging disabled
  - Exponential → the averaged FFT spectra are weighted inversely proportional to their 'age'
  - Normal → all averaged FFT spectra are weighted equally
- Average Cycles → number of the FFT spectra that are averaged for the current result display
- Average 'Reset' → click on the button to re-start the averaging process.
- 'Write Full Res. Results to file'
  - Active On → Full resolution mode is active
  - Active Off → Full resolution mode is disabled
- Format → the format, in which the numerical results are displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.

Example 1

Size (blocklength), No. of displayed Points and Resolution


Level [dB]
11.72 Hz (resolution)
Points = 4096
(displayed)
f [Hz]
5 6 7 8 9 10 20 30 40 50 60 80 100 200 300 500 800 1k 2k 3k 4k 5k 6k 8k 10k 20k 30k 40k 60k 80k
Size = 16384 samples (FFT calculation base)

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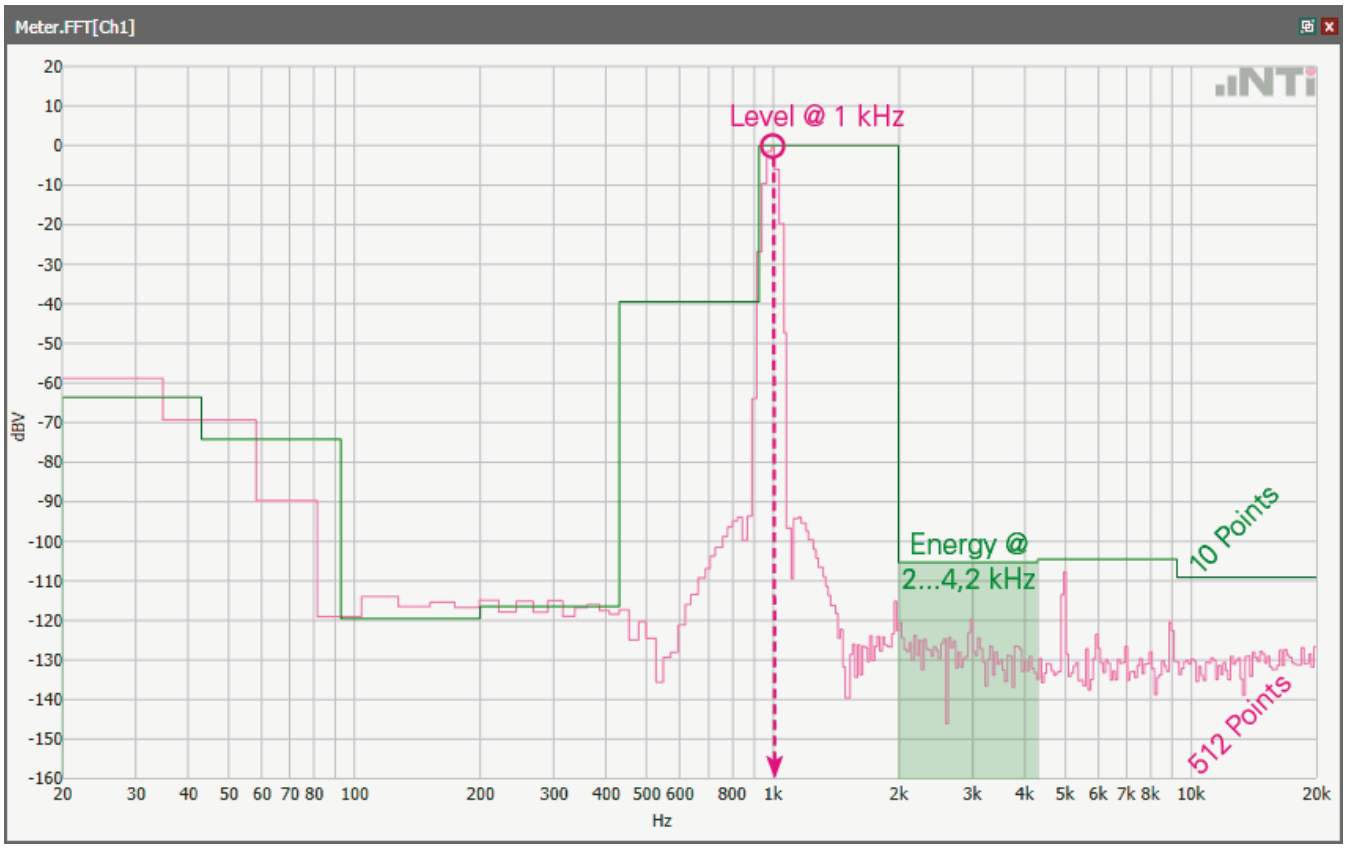
Example 2

Detector Type "Max Peak" vs. "Power"



Pink curve: Max Peak @ 512 Points ⇒ each point of the curve shows the voltage at the corresponding frequency

Green curve: Power @ 10 Points ⇒ the displayed values represent the energy in the corresponding frequency band

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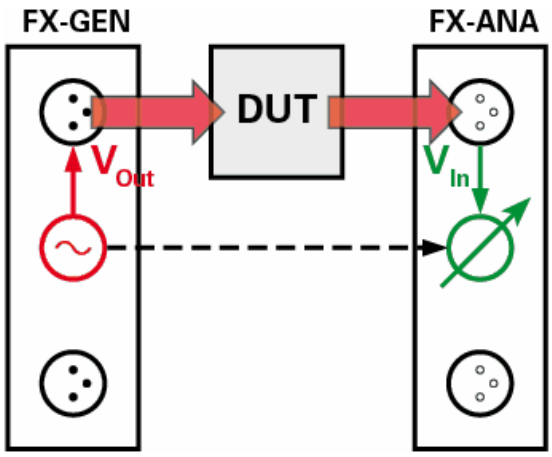
8.4.4 Gain

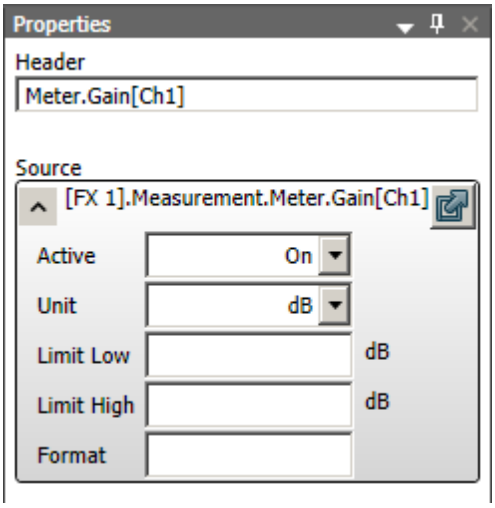
The ratio between the generated output level and the measured input level of the same channel gives the gain.

$$Gain = 20\log\left(\frac{V_{In}}{V_{Out}}\right)[dB] = \left(\frac{V_{In}}{V_{Out}}\right) * 100[\%]$$



Hint ***The link between the analyzer and the generator is established internally (i.e. there is no need for an external connection)***

Properties



- Header → editable name of the gain measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit → the measurement unit in which the measured gain shall be expressed
  - dB
  - %
- Limit(s)
  - Low (*Meter mode*) → optionally enter the lower tolerance limit of the measurement
  - High (*Meter mode*) → optionally enter the upper tolerance limit of the measurement
  - Edit Data... (*StepSweep*) → optionally edit the tolerance limits of the measurement

Hint ***It is possible to enter no limit, only the upper or the lower limit, or both limits***

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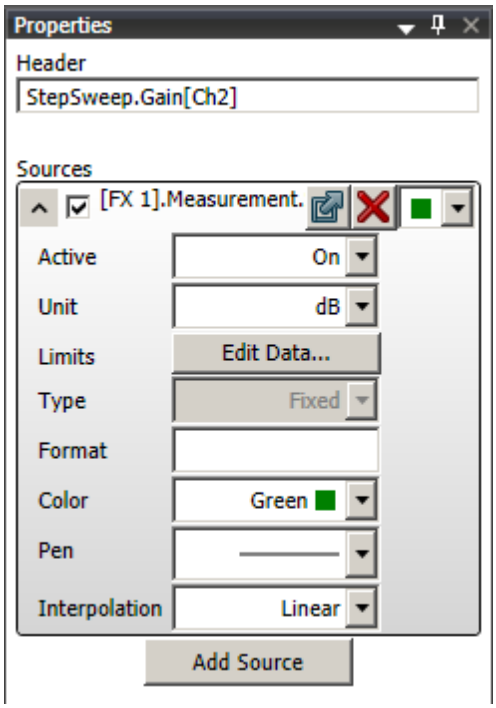
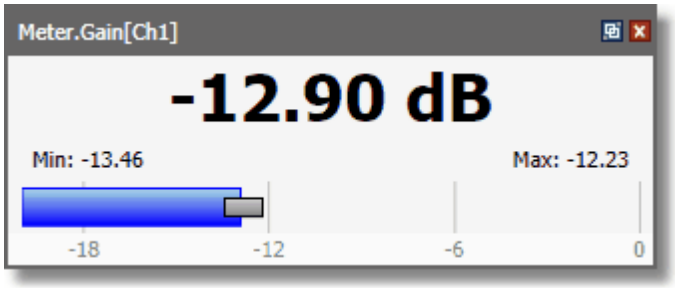


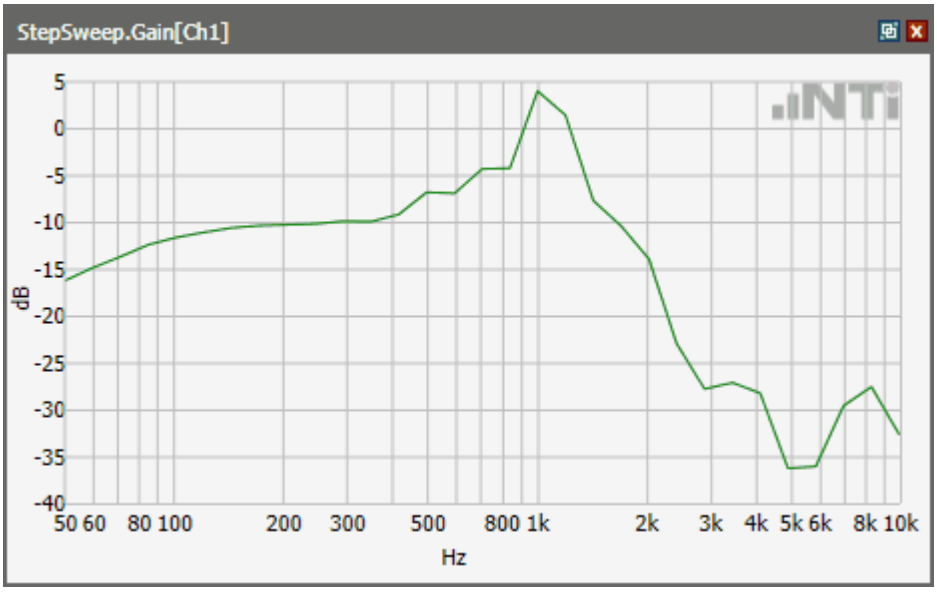
- Type → *not yet implemented* (absolute or floating tolerance limits)
- Format → the format in which the numerical results are displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.

Result display

The Meter gain measurement results can be displayed either as a numerical value or in a bargraph.



The StepSweep gain measurement results are displayed in a graph.



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8.4.5 THD, THDN, harmonics

FX100 supports three different harmonic distortion(s) measurements.

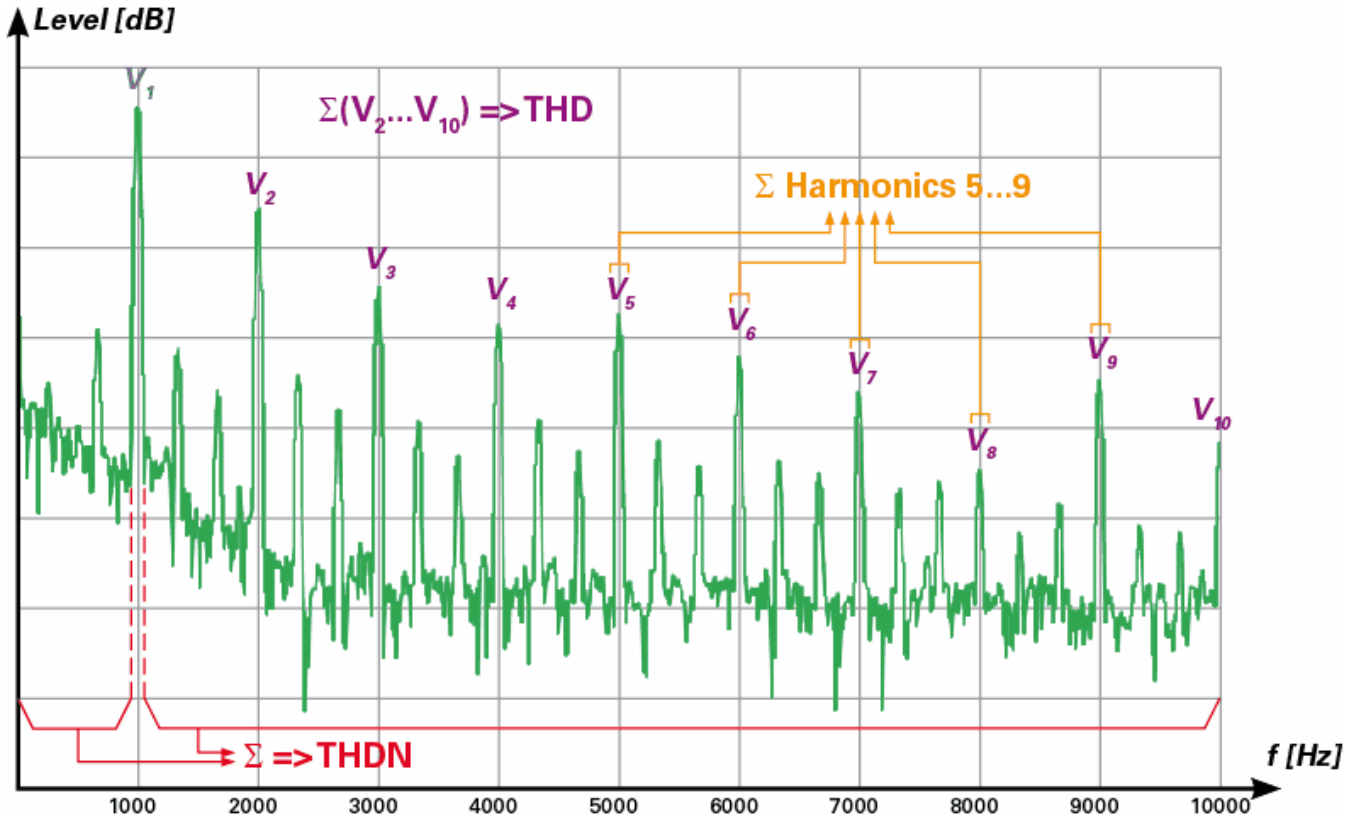
i. THD (Total Harmonic Distortion) → the sum of all harmonic distortions

ii. THDN (Total Harmonic Distortion + Noise) → the sum of all harmonic distortions + noise

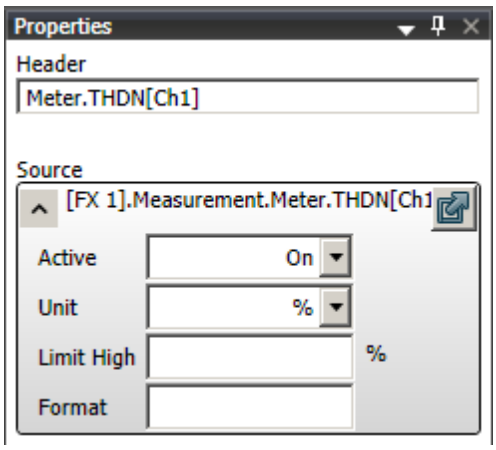
iii. Harmonics → the sum of a user-defined selection of harmonic distortions (up to six simultaneous harmonics measurements per channel are supported)

NOTE **If the distortion of an externally generated test signal is to be measured, the analyzer synchronization must be switched to 'External'.**

The THD measurement result can be calculated according to IEC or IEEE



THD, THDN properties



- Header → editable name of the THD, THDN measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Ext. Fund. Rejection (*THDN measurement only*) → the width of the notch filter that suppresses the fundamental sine wave. *Example:*

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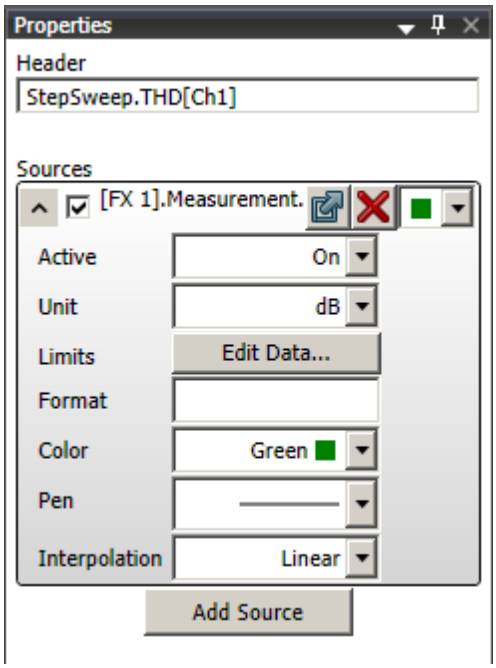

Side bands, which are, due to generator jitter, very close to the fundamental sine wave, can only be measured with 'Narrow' rejection.

- Narrow → extremely sharp adaptive notch filter
- Wide → filter with Q-factor 1.6

- Unit → the measurement unit in which the THD / THDN result is expressed
  - V
  - dBV
  - dBPa
  - dBSPL
  - dBu
  - %
  - dB
  - dBr

Hint ***With the dBr measurement it is possible to compare the input signal to a user-defined reference level.***

- Limit(s)
  - High (*Meter mode*) → enter the upper tolerance limit for the THD, THDN measurement
  - Edit Data... (*Sweep mode*) → edit the upper tolerance limits for the frequency sweep
- Format → the format in which the numerical results are displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.

Hint ***With the THD+N measurement it is possible to select the width of the notch filter, which suppresses the fundamental sine wave. The 'Ext. Fund. Rejection' is accessible via the properties of the THDN item in the toolbox, and can have following states:***

Narrow → extremely sharp adaptive notch filter

Wide → filter with Q-factor 1.6

Example

Side bands, which are, due to generator jitter, very close to the fundamental sine wave, can only be measured with 'Narrow' rejection.

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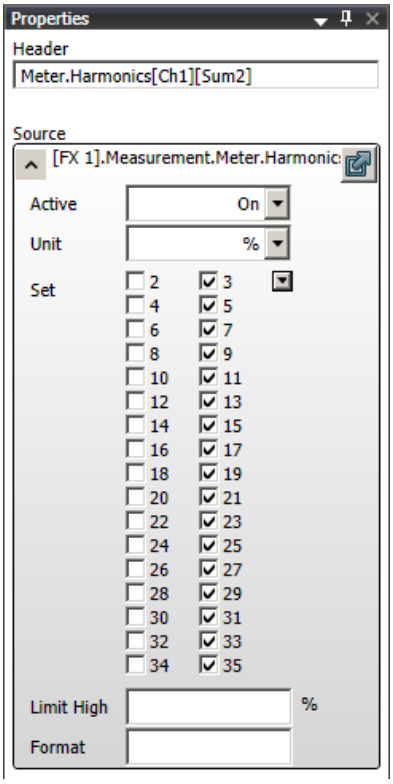
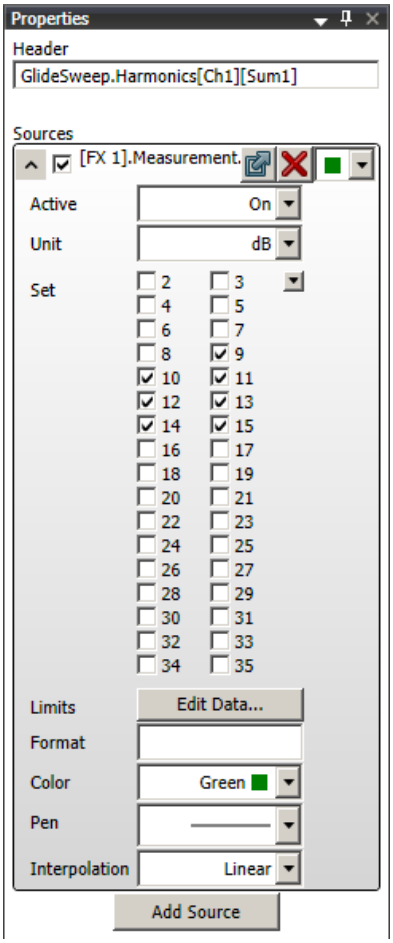
Harmonics properties



- Header → editable name of the THD, THDN measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit → the measurement unit in which the distortion result shall be expressed

Hint ***The selected measurement unit applies for all measurements of the same type***

- Set → define the required harmonics group
  - tick the harmonics that have to be measured
  - clear the checkboxes of those harmonics that should be ignored
- Click on the button to
  - Select All harmonics
  - Clear All checkboxes
  - sum up the Odd harmonics
  - sum up the Even harmonics
- Limit(s)
  - High (*Meter mode*) → enter the upper tolerance limit for the harmonics measurement
  - Edit Data... (*Sweep mode*) → edit the upper tolerance limits for the frequency sweep
- Format → the format in which the numerical frequency result is displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.



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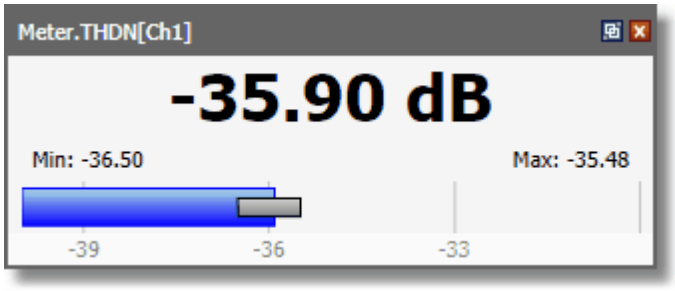
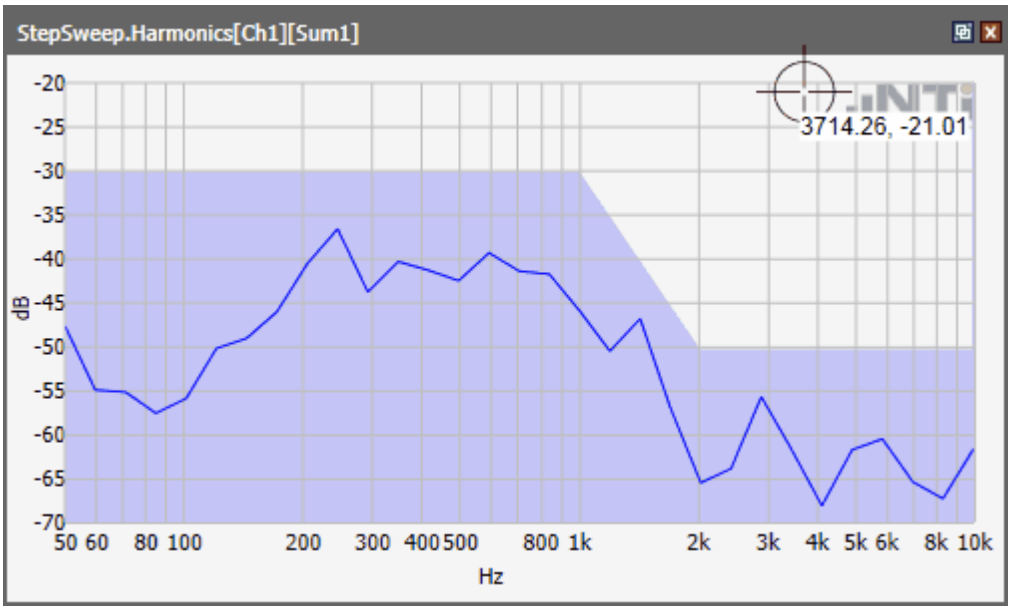
Result display

The Meter distortion results can be displayed either as a numerical value or in a bargraph.



The StepSweep or GlideSweep distortion results are displayed in a graph.



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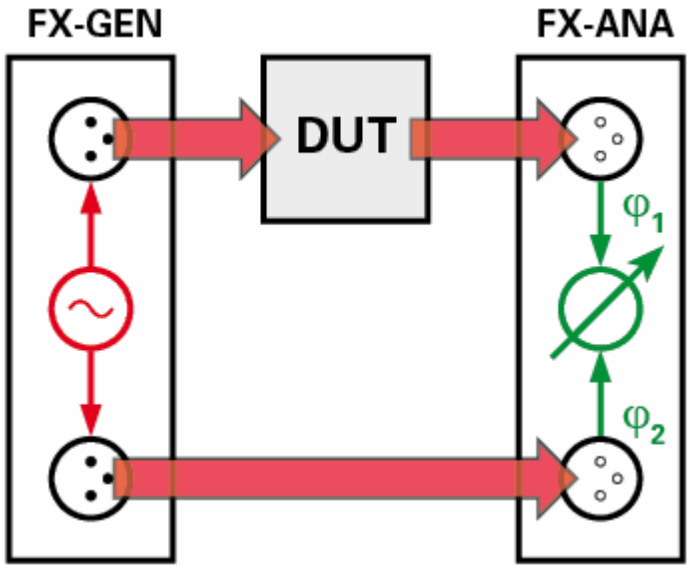
8.4.6 Phase (interchannel)

The interchannel phase measures the phase shift between the generator, analyzer channels.

$$Phase = \varphi_2 - \varphi_1$$

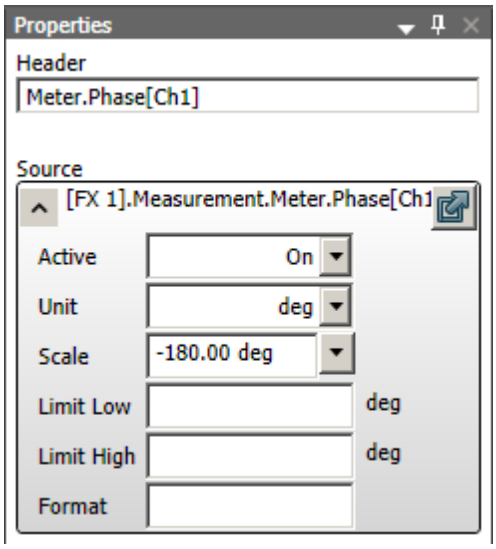


The test system has to be prepared as follows.

1. Switch the FX100 Meter, StepSweep generator to waveform 'Mono'.
2. Connect the generator output channel via the DUT (Device Under Test) to an analyzer input channel.
3. Link the alternate generator channel to the free analyzer channel.

NOTE The interchannel phase can only be measured between the channels of the same analyzer board, i.e. chn1 - chn2 or chn3 - chn4.

Properties



- Header → editable name of the phase measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit → the measurement unit in which the phase result is expressed
  - deg → degree (0°...360°)
  - rad → radiant (0...2π)
- Scale → the value, at which the phase result rolls over by 360° / 2π (*see example below*)

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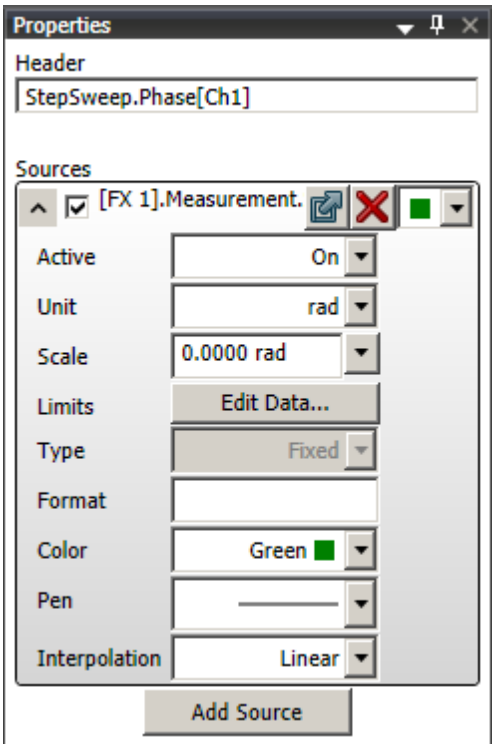


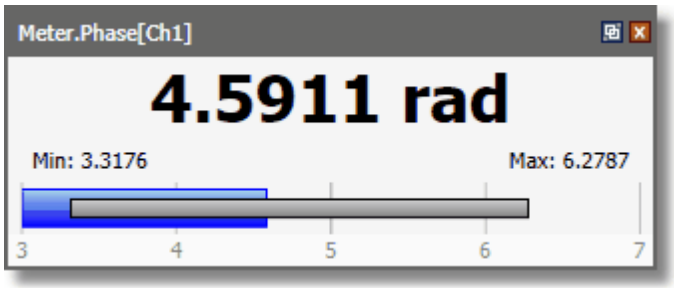
- Limit(s)
  - Low (*Meter mode*) → optionally enter the lower tolerance limit of the measurement
  - High (*Meter mode*) → optionally enter the upper tolerance limit of the measurement
  - Edit Data... (*StepSweep*) → optionally edit the tolerance limits of the measurement

Hint ***It is possible to enter no limit, only the upper or the lower limit, or both limits.***

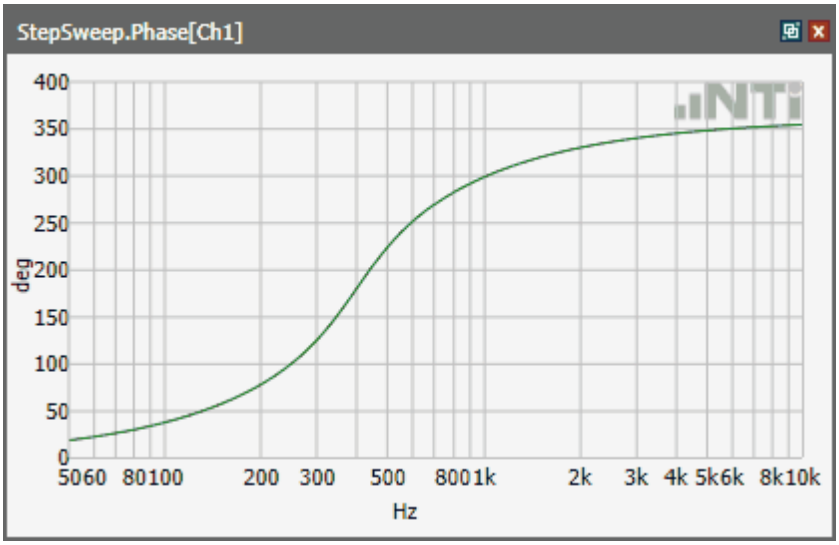
- Type → *not yet implemented* (absolute or floating tolerance limits)
- Format → the format in which the numerical results are displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.

Result display

The Meter phase results can be displayed either as a numerical value or in a bargraph.



The StepSweep phase results are displayed in a graph.



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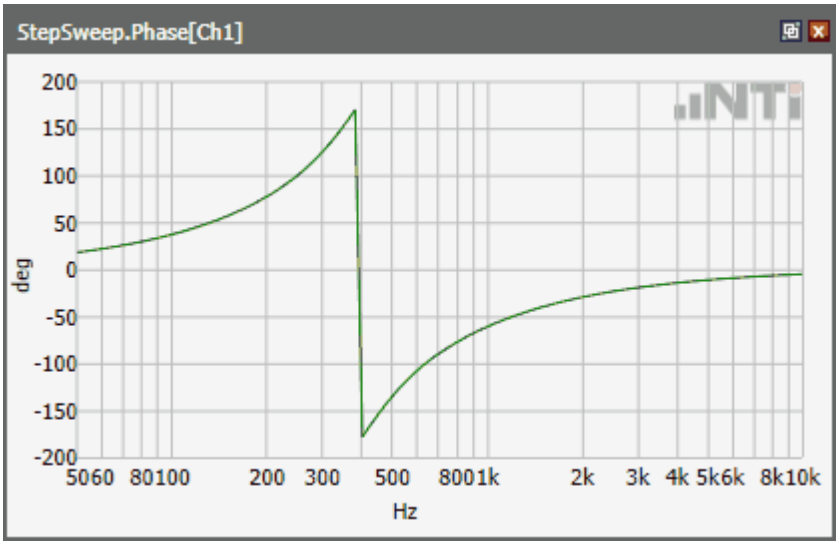

Interchannel phase measurements with parameter 'Scale' set to 0° (top) and 180° (bottom)

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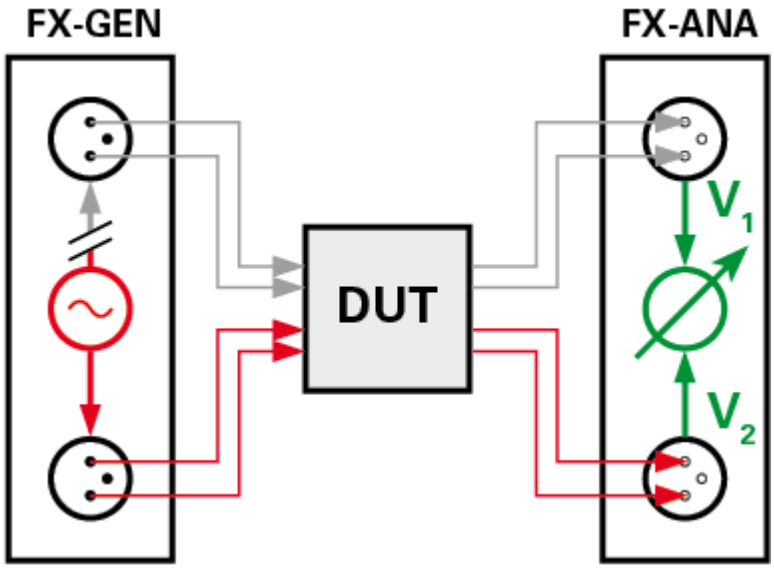
8.4.7 XTalk (interchannel)

The amount by which the voltage of one channel interferes with the alternate channel gives the interchannel crosstalk.

$$XTalk = 20\log\left(\frac{V_{MutedChn}}{V_{ActiveChn}}\right)[dB] = \left(\frac{V_{MutedChn}}{V_{ActiveChn}}\right) * 100[\%]$$

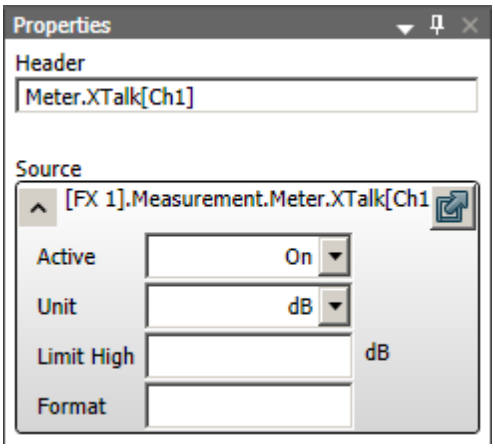


A typical XTalk measurement is executed as follows.

1. Establish the connections from the FX100 generator via the DUT (Device Under Test) to the analyzer.
2. Switch OFF (i.e. mute) the generator output of the channel to be measured.
3. Start the measurement. The active test signal is thereby transmitted through the active channel, while the level of the inactive channel is measured.

NOTE The interchannel XTalk can only be measured between the channels of the same analyzer board, i.e. chn1 - chn2 or chn3 - chn4.

Properties



- Header → editable name of the XTalk measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive

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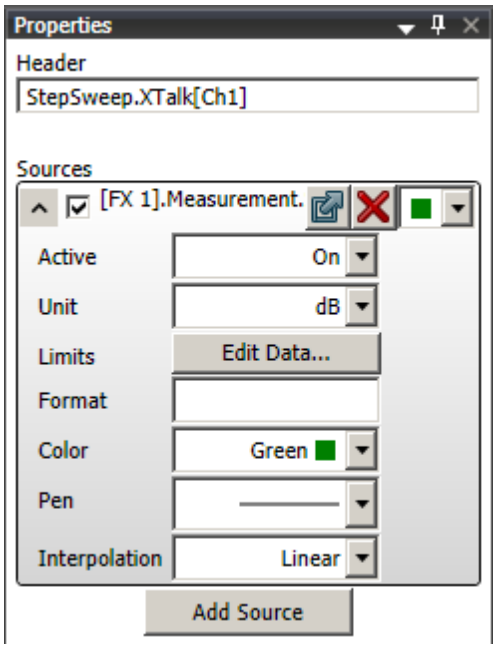
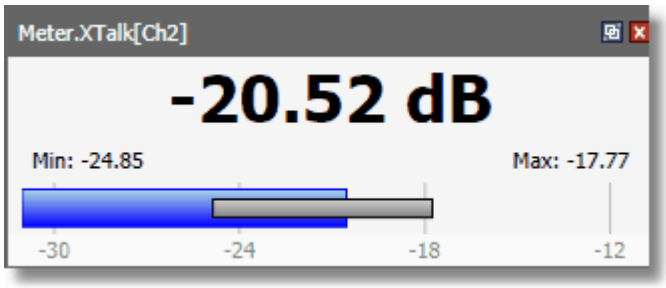


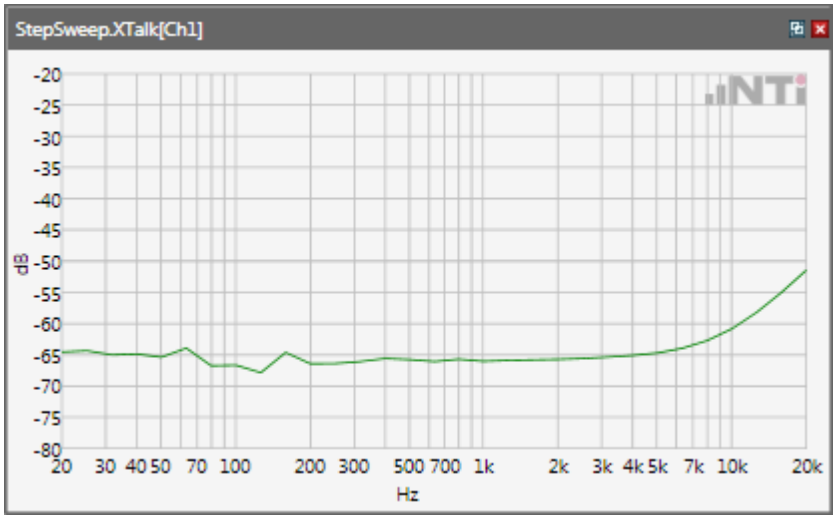
- Unit → the measurement unit in which the measured XTalk shall be expressed
  - dB
  - %
- Limit(s)
  - High (*Meter mode*) → optionally enter the upper tolerance limit of the measurement
  - Edit Data... (*StepSweep*) → optionally edit the tolerance limits of the measurement
- Format → the format in which the numerical results are displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.

Result display

The Meter XTalk results can be displayed either as a numerical value or in a bargraph.



The StepSweep XTalk results are displayed in a graph.



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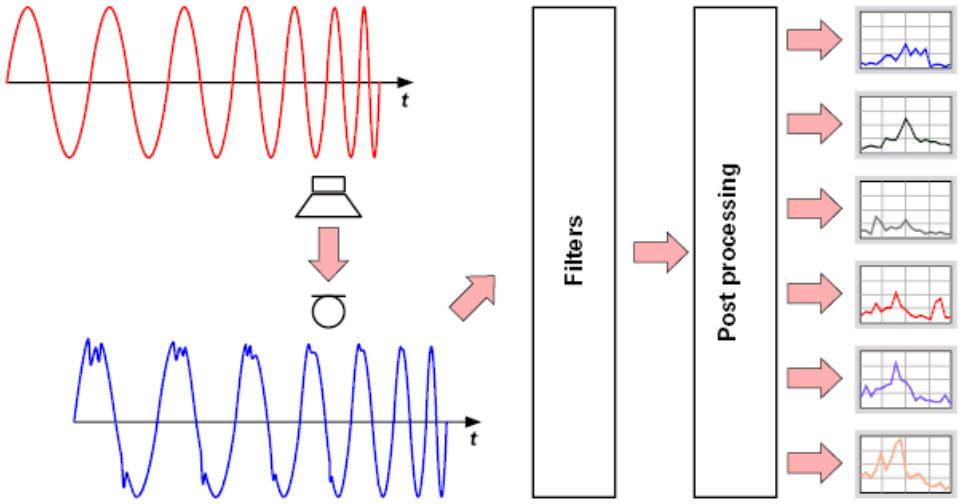
8.4.8 PureSound

NTi Audio's unique PureSound™ analysis measures the transient steepness of the received signal. The measurement provides, for instance, the facility to identify audible imperfections or other irregularities, which can not be detected by conventional test methods such as distortion analysis.

The schematic picture below explains the basic principle behind PureSound analysis.

- Six filters divide the transmitted signal into separate components.
- Every signal component is post-processed by the PureSound algorithm.

⇒ *As opposed to distortion analysis, PureSound analysis operates in the time domain.*

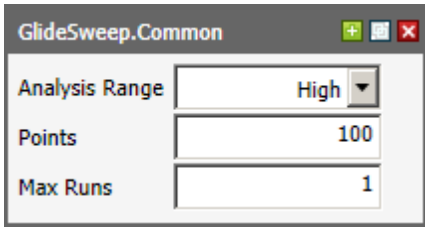


PureSound measurements are typically used for the analysis of

A) Sinusoidal signals	*B) Complex sound*
• Constant sine tone (Meter mode) • Linear GlideSweep • Logarithmic GlideSweep ⇒ Peak(s) in the resulting steepness graphs indicate irritating noise.	• Mobile phone ringing tone • Machinery noise ⇒ The resulting steepness graphs represent a 'fingerprint' of the original signal, and can be used for correlation tests.

Hint ***StepSweep is not suited for PureSound analysis***

Properties



Common

- Analysis Range → select the bandpass filters for steepness analysis,
  - Low → 60...480 Hz
  - Mid → 340...2800 Hz
  - High → 2...20 kHz (*complies to the filters of RT-2M*)
- Points (*GlideSweep only*) → the number of steepness result values that are uploaded to the controller PC (i.e. the resolution of the displayed steepness response curve - *see Example below*)
- Max Runs (*GlideSweep only*) → the number of times the PureSound test is repeated if the measurement results exceed the tolerance limits. The system then compares the data of the executed cycles to eliminate all non-recurring peaks (e.g stochastic ambient noise), and thus considers only systematic events (*see Example below*).

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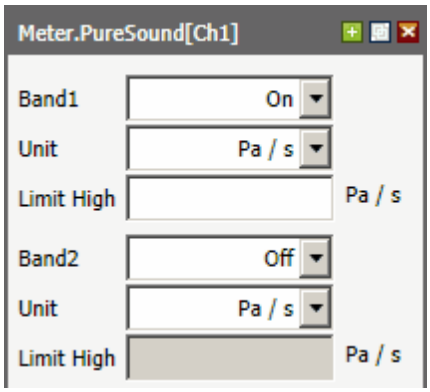
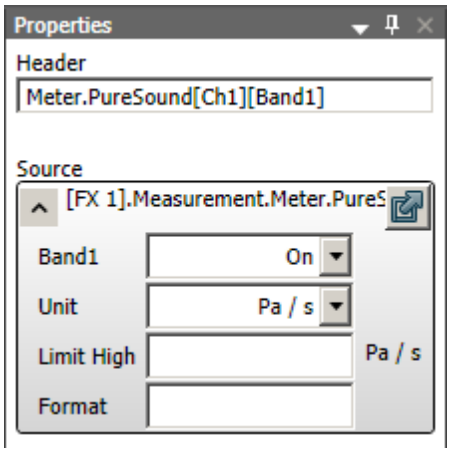


ChannelX

- BandX → The six frequency bands of PureSound analyzes can be enabled ('On') or disabled ('Off') individually.
- Unit → the measurement unit in which the PureSound band result is expressed
  - Pa/s
  - V/s
- Limit(s)
  - High (*Meter mode*) → enter the upper tolerance limit for the PureSound measurement
  - Edit Data... (Glide*Sweep mode*) → edit the upper tolerance limits for the steepness analysis

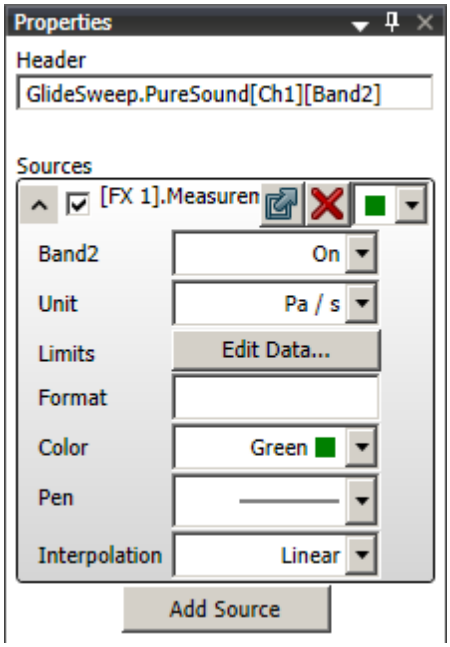


Result display (Meter or GlideSweep)

- Header → editable name of the PureSound measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.

- BandX → The six frequency bands of PureSound analyzes can be enabled ("On") or disabled ("Off") individually.
- Unit → the measurement unit in which the PureSound band result is expressed

Hint ***The selected measurement unit applies for all PureSound bands***



- Limit(s)
  - High (*Meter mode*) → enter the upper tolerance limit for the PureSound measurement
  - Edit Data... (*GlideSweep mode*) → edit the upper tolerance limits for the steepness analysis
- Format → the format in which the numerical results are displayed.
- Color (*GlideSweep mode*) → selectable color of the corresponding curve.
- Pen (*GlideSweep mode*) → selectable line style of the corresponding curve.
- Interpolation (*GlideSweep mode*)
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source (*GlideSweep mode*) → click on this button to select and place another measurement on the worksheet.

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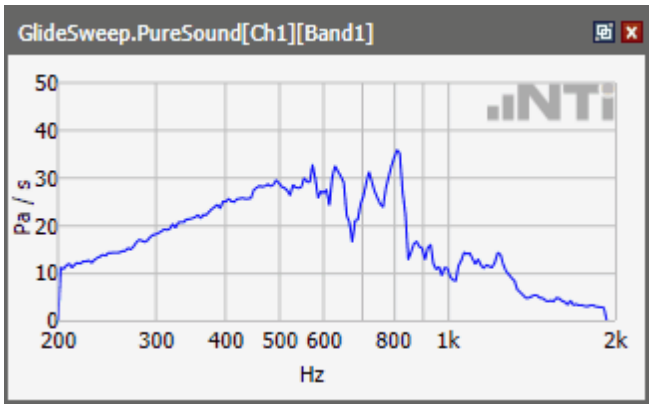
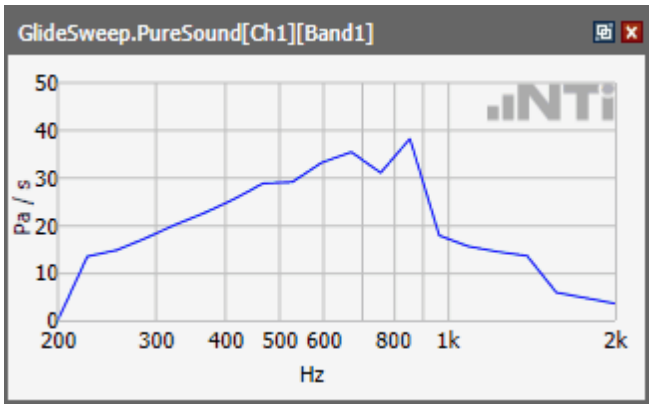
Example for parameter 'Points'

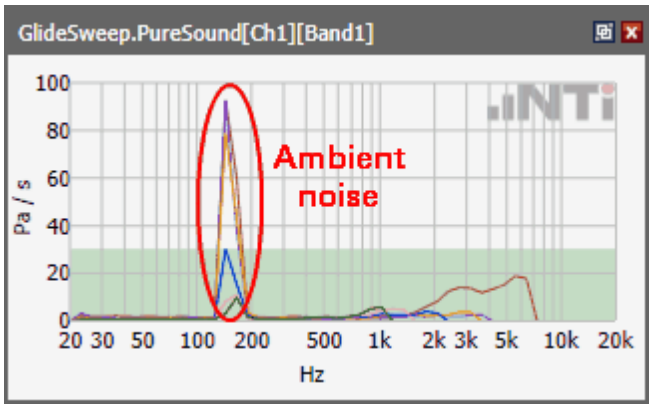


Steepness response with 200 points

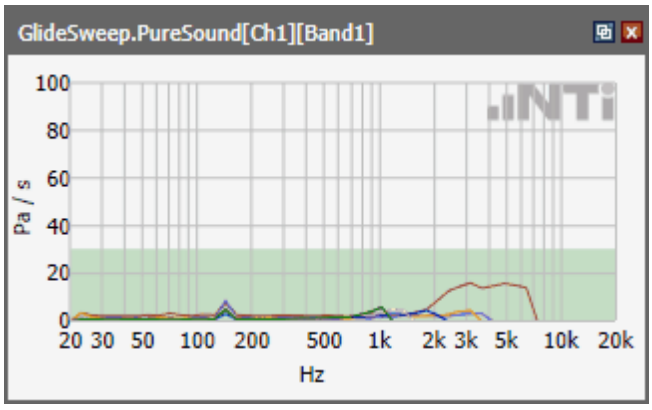


Steepness response with 20 points

Example for parameter 'Max Runs'



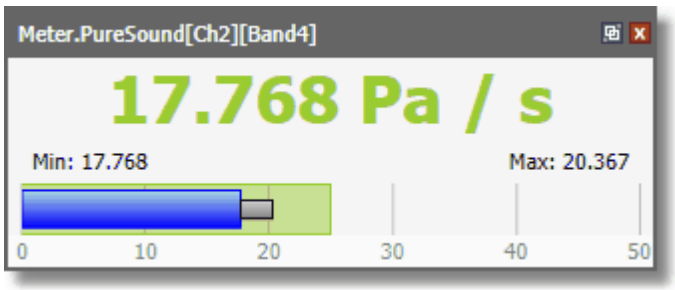
During the 1st cycle, a peak exceeds the given tolerance limits ⇒ the test is repeated



During the 2nd cycle (same DUT - Device Under Test), all steepness curves are within the limits ⇒ the peak from the 1st cycle was caused by ambient noise, i.e. the DUT is OK

Result display

The Meter steepness results can be displayed either as a numerical value or in a bargraph.



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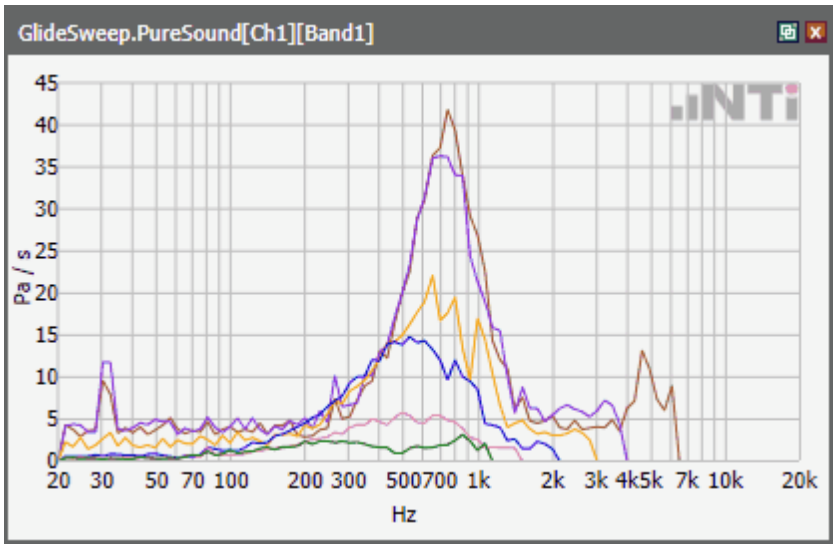
The GlideSweep PureSound results are displayed in a graph.



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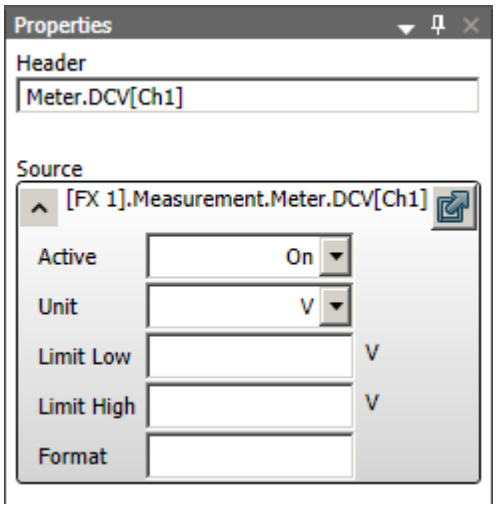
8.4.9 DCV

FX100 supports three DC measurements. The analyzer coupling must be set to 'DC'.

1. DCV → the Voltage between
   - XLR pin 2 and pin 3, or
   - BNC center pin and shield
2. DCVCommonHigh → the common-mode Voltage between XLR pin 2 and pin 1
3. DCVCommonLow → the common-mode Voltage between XLR pin 3 and pin 1

Hint ***Since DCV and the AC measurements require different settings, they must be executed sequentially.***

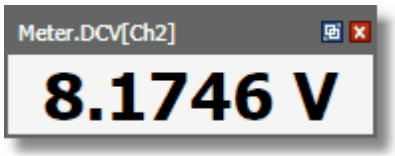
Properties

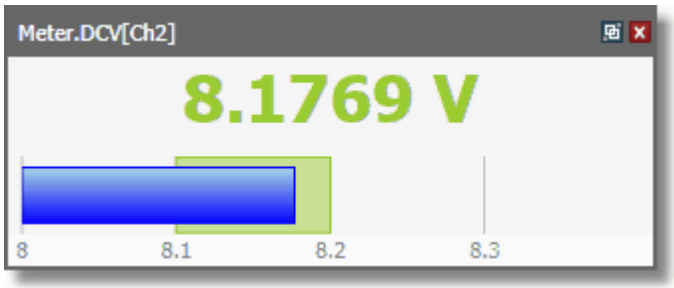


- Header → editable name of the DCV measurement display.
- Sources → measurement function.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit → Volt
- Limit
  - Low → optionally enter the lower tolerance limit for the DCV measurement
  - High → optionally enter the upper tolerance limit for the DCV measurement
- Format → the format in which the numerical results are displayed.

Result display

The DCV results can be displayed either as a numerical value or in a bargraph.





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8.4.10 DCR

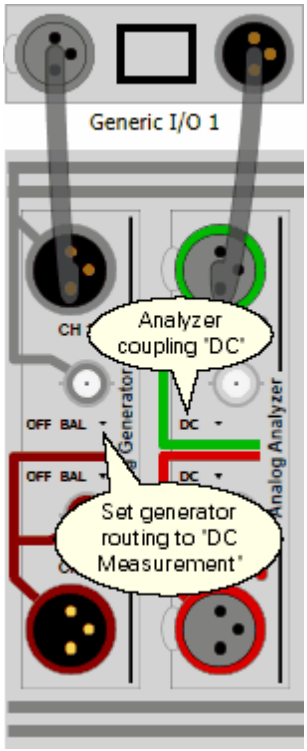
For a DCR measurement, the analyzer generates a constant current to measure the voltage across the DUT (Device Under Test).

Test setup & execution

- Establish a link between the DUT input and the connectors of the analyzer channel
- Switch the analyzer coupling to DC
- Adjust the bias of the board that is directly connected to the DUT input, i.e.
  - FX-ANA → bias "DCR 5k range" or "DCR 100k range"
  - FX-SIL → "DCR 32E range"
  - FX-SIH → "DCR 4E range"
- Place a DCR measurement display on the Worksheet and start the measurement.

Hint ***Since DCR and the AC impedance measurements require different settings, they must be executed sequentially.***

Example A



Measure the DC input impedance of a DUT that is directly connected to the FX100 generator output.

1. Switch to the Hardware & Wiring view.
2. Activate the "DC Measurement" routing on the corresponding output channel, using
   - a right-click on the button of the generator board, or
   - the generator board properties.
3. Switch the analyzer coupling of the corresponding channel to "DC".
4. Activate the analyzer bias current according to the expected impedance of the DUT
   - DCR 5k range → 1.6 mA for up to 5 kΩ
   - DCR 100k range → 100 µA for up to 100 kΩ

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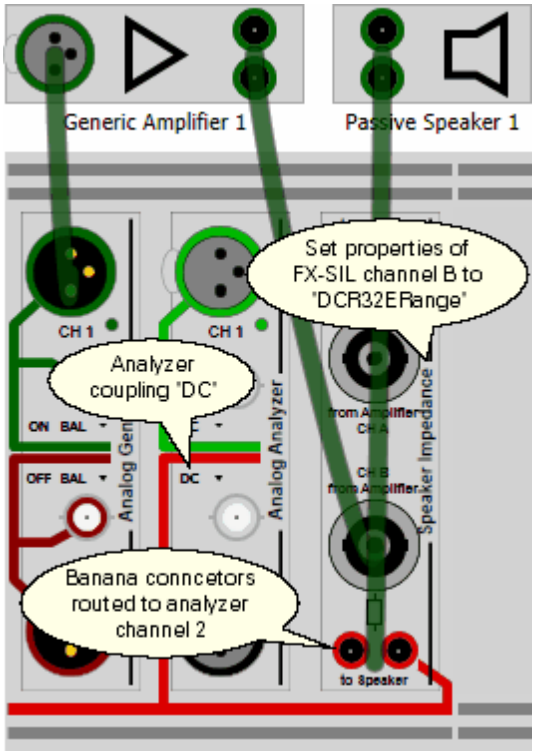
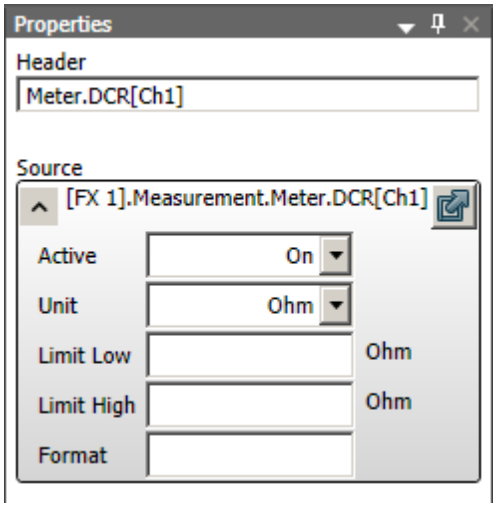
Example B



Measure the DC impedance of a loudspeaker that is connected to FX100 via the FX-SIL board.

1. Switch to the Hardware & Wiring view.
2. Switch the analyzer coupling of the corresponding channel to "DC".
3. Activate the "DCR32ERange" mode in the FX-SIL properties.

Properties



- Header → editable name of the DCR measurement display.
- Sources → measurement function.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit → Ohm
- Limit
  - Low → optionally enter the lower tolerance limit for the DCR measurement
  - High → optionally enter the upper tolerance limit for the DCR measurement
- Format → the format in which the numerical results are displayed.

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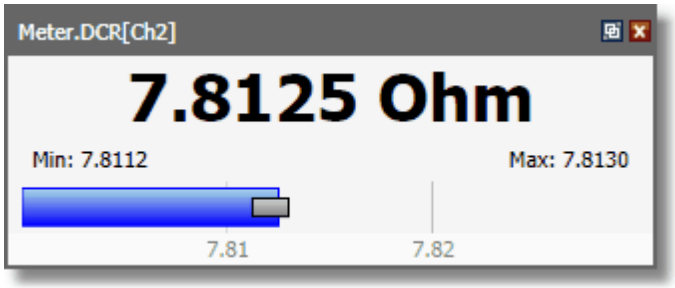
Result display

The DCR results can be displayed either as a numerical value or in a bargraph.



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8.4.11 Speaker impedance

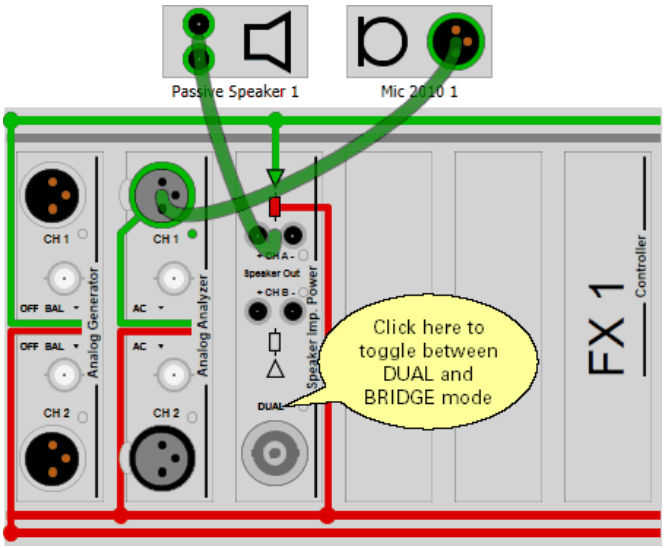
The speaker impedance measurement records the impedance response of the connected DUT (Device Under Test).

NOTE This measurement function is only available if an SIP, SIL or SIH board is installed

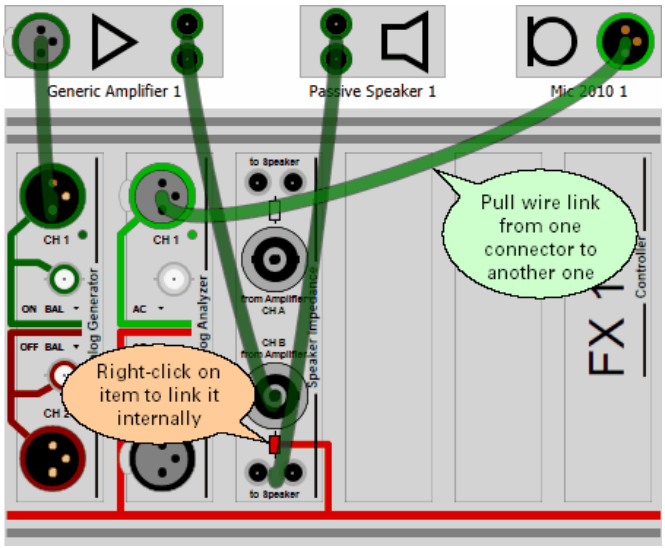
Test setup & execution ...

... with FX-SIP	... with FX-SIL or FX-SIH
1. Select the operation mode, DUAL (2*10 W) or BRIDGE (1*30 W) 2. Connect the generator output(s) to the integrated amplifier(s) 3. Connect the amplifier output(s) to the DUT(s) 4. Link the SIP current sensor(s) to the analyzer. 5. Adjust the GlideSweep input range 6. Start the measurement.	1. Connect the generator output(s) to an external amplifier. 2. Connect the amplifier output(s) to the SIL, SIH input(s). 3. Connect the SIL, SIH output(s) to the DUT(s). 4. Link the SIL, SIH current sensor(s) to an analyzer channel. 5. Temporarily link the SIL, SIH input connector (Speakon™) to a free analyzer channel and ○ adjust the GlideSweep input range ○ execute a generator equalization ○ enter the calibrated amplifier output level as 'VoltageValue' in the properties (see below) ○ re-establish the standard measurement link. 6. Start the measurement.

Setup examples



SIP wiring for 1-channel speaker frequency & impedance response measurement



SIL wiring for 1-channel speaker frequency & impedance response measurement

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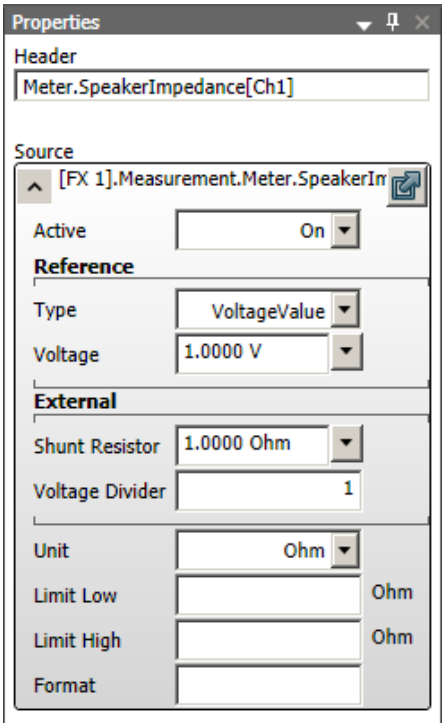
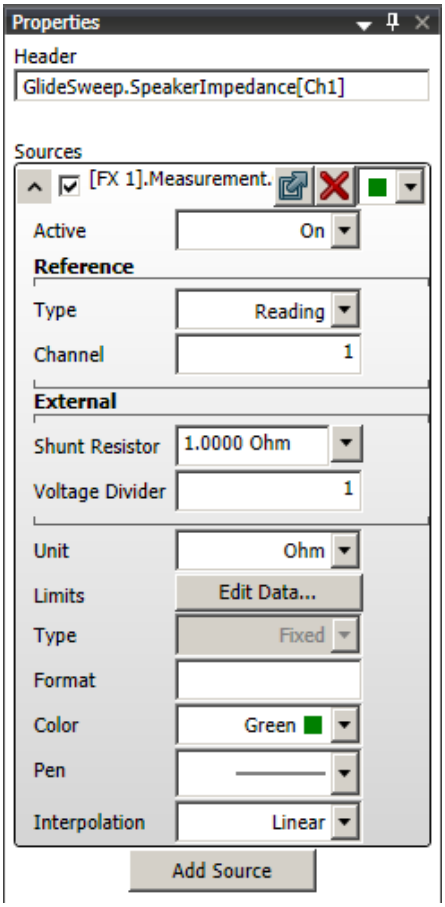
Properties





- Header → editable name of the level measurement display.
- Sources → measurement function.
  - Clear the ☑ checkbox to hide the corresponding curve in the graph.
  - Click on the button to amend the measurement function.
  - Click on the button to delete the corresponding curve.
  - Click on the button to amend the curve color.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Reference Type → for a correct measurement, either
  - select 'VoltageValue' and enter the calibrated amplifier output voltage, or
  - select 'Reading' and link the Speakon™ input connector to a free analyzer channel
- External Shunt Resistor (*applies only if an external impedance test box is used*) → enter the impedance of the shunt resistor.
- External Voltage Divider (*applies only if an external voltage divider is used*) → enter the voltage divider ratio. *Example: "10" stands for "10:1"*
- Unit → Ohm
- Limit(s)
  - Low (*Meter mode*) → optionally enter the lower tolerance limit of the measurement
  - High (*Meter mode*) → optionally enter the upper tolerance limit of the measurement
  - Edit Data... (*Sweep mode*) → optionally edit the tolerance limits of the measurement

Hint ***It is possible to enter no limit, only the upper or the lower limit, or both limits***

- Type → *not yet implemented* (absolute or floating tolerance limits)
- Format → the format in which the numerical results are displayed.
- Color → selectable color of the corresponding curve.
- Pen → selectable line style of the corresponding curve.
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.

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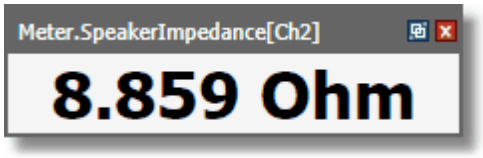
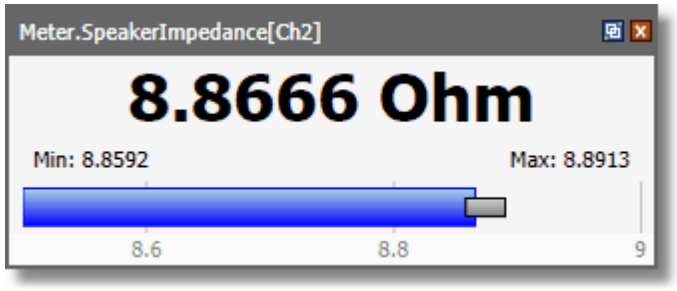
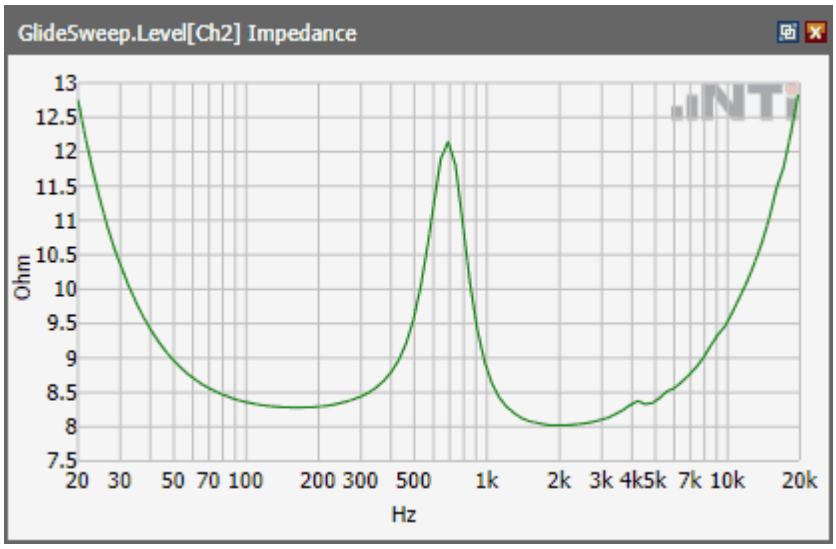
Result display

The Meter speaker impedance measurement results can be displayed either as a numerical value or in a bargraph.





The speaker impedance response results are displayed in a graph.



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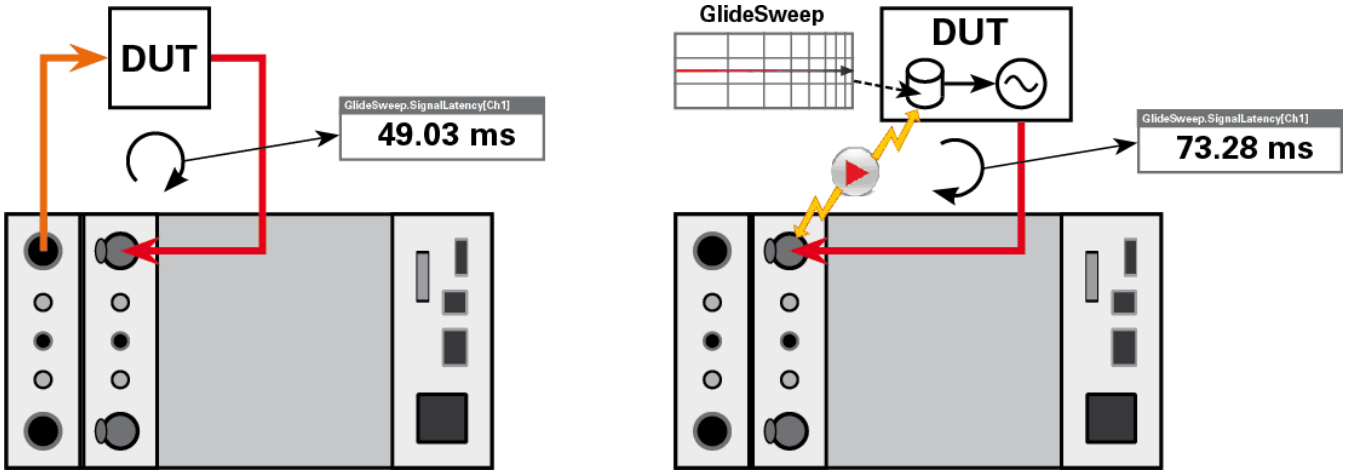
8.4.12 Signal latency

The signal latency is the time that it takes for a GlideSweep to propagate from the generator to the analyzer.



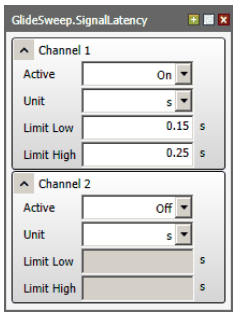
Schematic test setups for internal and external signal latency measurement

NOTE **If the signal latency shall be measured from an external device to the FX100 analyzer, you must make sure that the analyzer is started at the same time when the signal is generated by the external device (e.g. by triggering the two devices with an electrical signal).**

Test setup & execution

Follow the instructions given in the chapter "Application hints → External signal analysis".

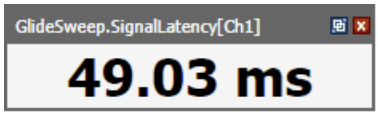
Properties

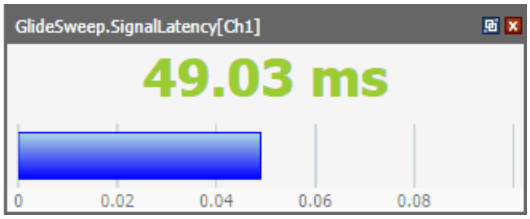


- Active → select the channel(s) for the signal latency measurement
- Unit → the measured delay can be expressed in seconds, or as distance*
  - seconds
  - meter
  - feet
- Limit(s)
  - Low → optionally enter the lower tolerance limit for the measurement
  - High → optionally enter the upper tolerance limit for the measurement

Result display

The GlideSweep signal latency measurement results can be displayed either as a numerical value or in a bargraph.





*: The calculation time → distance refers to the ambient temperature, which is defined in the toolbox under "Advanced → General"

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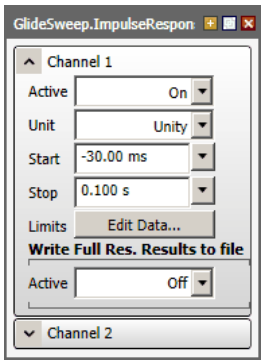
8.4.13 Impulse response

The impulse response is directly calculated from the acquired GlideSweep data.

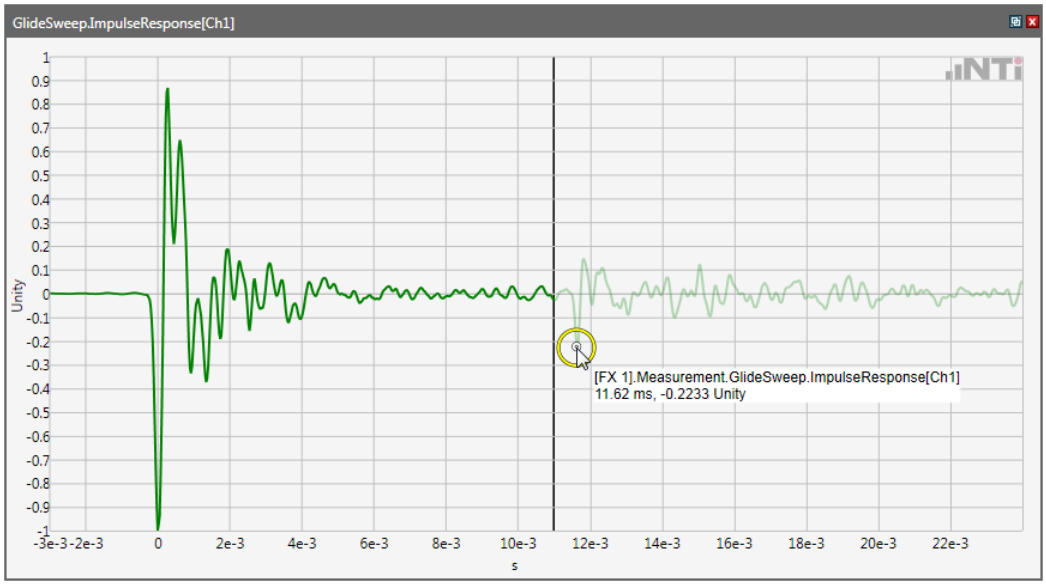
Properties



- Active → enable the channel(s) for the impulse response measurement
- Unit → Unity (–1...+1)
- Start, Stop → define the zoom range of the impulse response graph
- Limits → optionally enter the lower, upper tolerance limits for the measurement
- 'Write Full Res. Results to file'
  - Active On → Full resolution mode is active
  - Active Off → Full resolution mode is disabled

Result display

The impulse response results are displayed in a graph, whereby the grey vertical line indicates the end point of the active time window.



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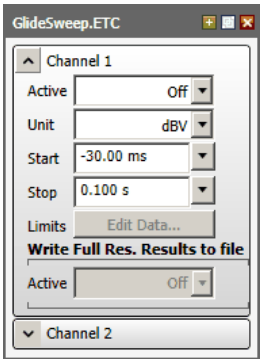
8.4.14 ETC

The ETC (Energy-Time Curve) is directly calculated from the acquired GlideSweep data.

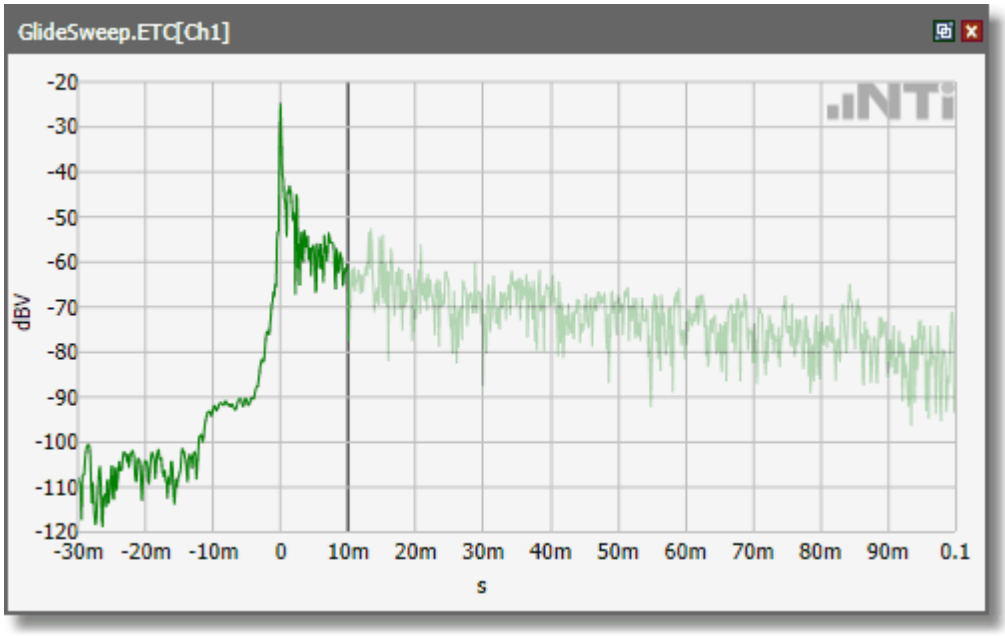
Properties



- Active → enable the channel(s) for the ETC measurement
- Unit → the unit of the Y-axis
- Start, Stop → define the zoom range of the ETC graph
- Limits → optionally enter the lower, upper tolerance limits for the measurement
- 'Write Full Res. Results to file'
  - Active On → Full resolution mode is active
  - Active Off → Full resolution mode is disabled

Result display

The ETC results are displayed in a graph, whereby the grey vertical line indicates the end point of the active time window.



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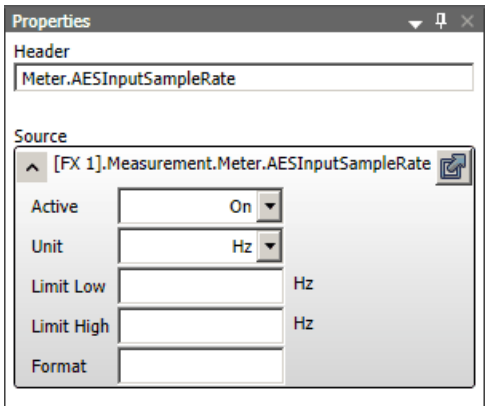
8.4.15 AES input sample rate

The AES input sample rate is the clock frequency of the incoming AES digital Audio signal.

NOTE This measurement function is only available if the FX-AES board is installed

Properties



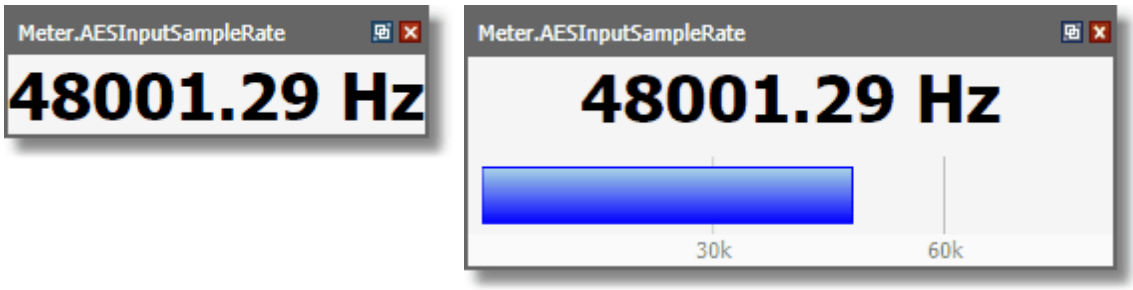
- Header → editable name of the AES input sample rate measurement display
- Source → measurement function; if it shall be amended, click on the button.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit
  - Hz → Hertz (must be selected for the Sample Rate Deviation)
  - ppmr → parts per million relative
- Limit(s)
  - Low → optionally enter the lower tolerance limit of the frequency measurement
  - High → optionally enter the upper tolerance limit of the frequency measurement

Hint ***It is possible to enter no limit, only the upper or the lower limit, or both limits***

- Format → the format in which the numerical results are displayed.

Result display

The AES sample rate measurement results can be displayed either as a numerical value or in a bargraph.



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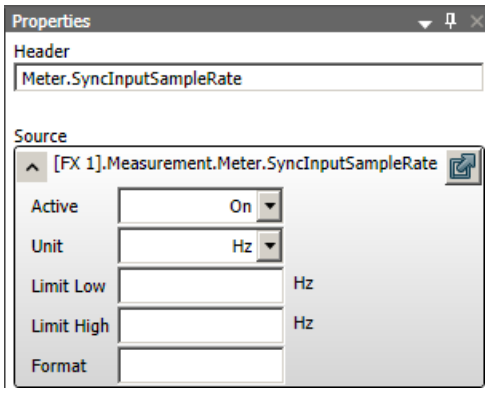
8.4.16 Sync input sample rate

The Sync input sample rate is the clock frequency at the Sync Ref. Input connector.

NOTE This measurement function is only available if the FX-AES board is installed

Properties



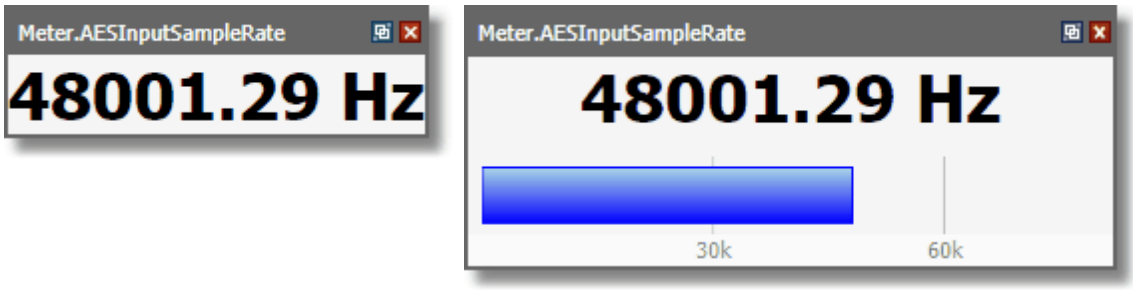
- Header → editable name of the Sync input sample rate measurement display
- Source → measurement function; if it shall be amended, click on the button.
- Active
  - On → measurement is active
  - Off → measurement is inactive
- Unit
  - Hz → Hertz (must be selected for the Sample Rate Deviation)
  - ppmr → parts per million relative
- Limit(s)
  - Low → optionally enter the lower tolerance limit of the frequency measurement
  - High → optionally enter the upper tolerance limit of the frequency measurement

Hint ***It is possible to enter no limit, only the upper or the lower limit, or both limits***

- Format → the format in which the numerical results are displayed.

Result display

The Sync input sample rate measurement results can be displayed either as a numerical value or in a bargraph.



8.4.17 Settling

FX100 applies an automated settling procedure to ensure that the acquired results are stable and relevant. Some static and dynamic parameters of this procedure can be edited manually if required (please refer to chapters Meter, StepSweep).

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8.4.18 Units

The units of the FX100 measurement functions can be divided into two groups, absolute and relative units.

a) Absolute units

Unit	*Explanations*
A	Ampere – current (only available for calculation items)
dBFS	decibel full scale – for digital Audio
dBFSp	decibel full scale peak – for digital Audio
dBPa	decibel Pascal – for acoustic measurements
dBSPL	decibel sound pressure level – for acoustic measurements
dBu	decibel relative to 0.7746 V – for Voltage measurements
dBup	decibel relative to 0.7746 V peak – for Voltage measurements
dBV	decibel relative to 1.0 V – for Voltage measurements
dBV / Pa	decibel Volt per Pascal – microphone sensitivity
dBVp	decibel Volt peak – for Voltage measurements
deg	degree [angle] – for Phase measurements
Deg C	degree Celsius – temperature (only available for calculation items)
Deg F	degree Fahrenheit – temperature (only available for calculation items)
Feet	Feet – distance (only available for calculation items)
FFS	fraction of full scale – for digital Audio
FFSp	fraction of full scale peak – for digital Audio
Hz	Hertz – for frequency measurements
Meter	Meter – distance (only available for calculation items)
mV / Pa	Millivolt per Pascal – microphone sensitivity
Ohm	Ohm – for impedance measurements
Pa / s	Pascal per Second – for PureSound measurements
%FS	percent full scale – for digital Audio
%FSp	percent full scale peak – for digital Audio
rad	Rad – for Phase measurements
s	Second – time
V	Volt – for Voltage measurements
Vp	Volt peak – for Voltage measurements
V / s	Volt per Second – for PureSound measurements
W	Watt – electric power (only available for calculation items)

b) Relative units

dB	decibel
dBr	decibel relative
%	percent
%Tol	percent tolerance
ppm	parts per million
ppmr	parts per million relative

Hint ***The results of some measurement functions can be displayed either in an absolute or relative unit, e.g.***
Level → V or dBu, dBV
THD → V or dB, %
The corresponding sweep curves can therefore vary significantly in their shapes

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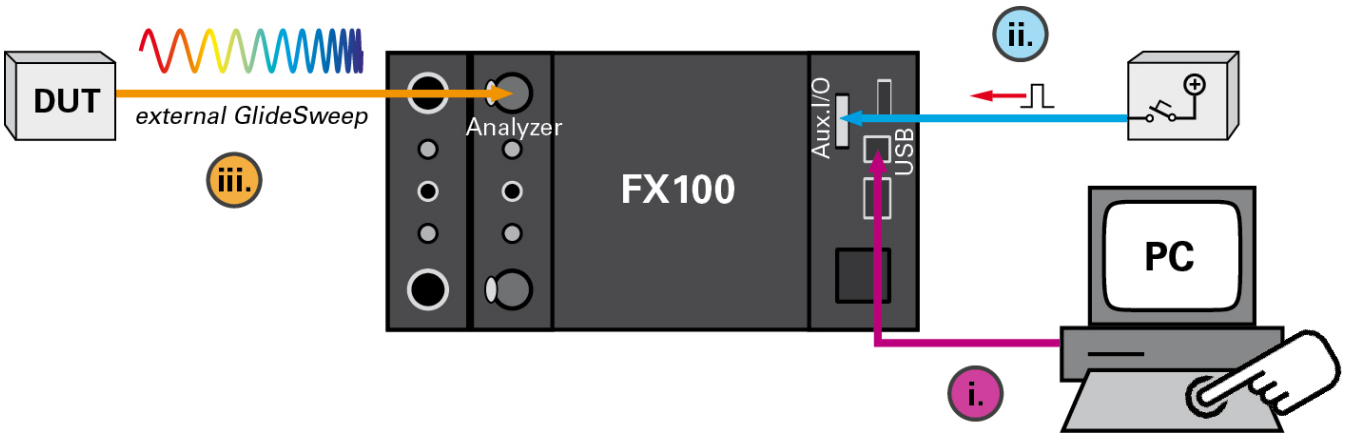
8.5 Measurement execution

The active measurements or a sequence can be initiated in three different ways.

i. The user manually gives the start command via the PC keyboard (see below).

ii. An external device (e.g. PLC or foot switch) triggers the test via the auxiliary I/O interface.

iii. The user arms the FX100 analyzer in GlideSweep mode, then the instrument automatically starts the measurement as soon as it detects a header.



Triggering methods

i. Manually start the active measurements or sequence

or **F5**	All Single → starts a single execution of the active Meter, StepSweep and GlideSweep measurements of all connected FX100 Devices
or **F6**	All Repeat → starts repeated execution of the active Meter, StepSweep and GlideSweep measurements of all connected FX100 instruments
, , *or*	Meter, StepSweep, GlideSweep → FX100 starts continuously measuring in the corresponding mode
Single	Single → the instrument executes a single measurement of all active panels in the Worksheets
Repeat	Repeat → the instrument starts repeated measurements of all active panels in the Worksheets
Abort or **F8**	Abort the running measurement

ii. Initiate the active measurements via the auxiliary I/O

- Click on the dialog box launcher in the Start ribbon.

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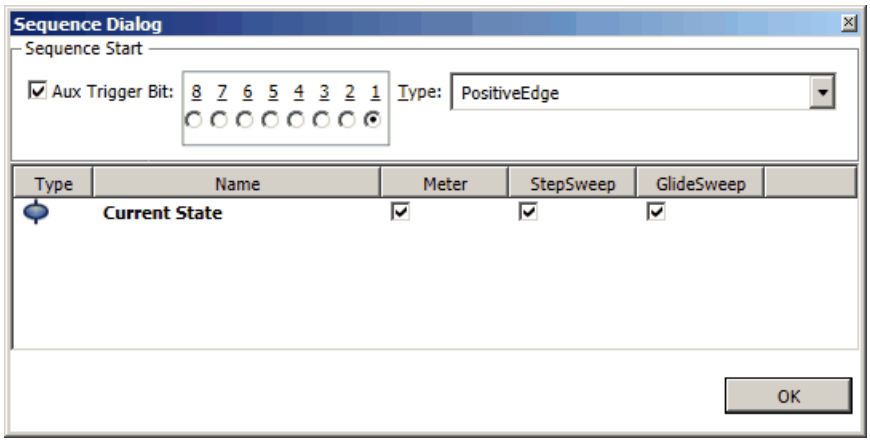
- In the 'Sequence Dialog' box,
  - tick the checkbox 'Aux Trigger Bit',
  - select the auxiliary input pin that shall be used to trigger the measurement,
  - select the trigger signal Type (positive or negative edge)



Hint ***This setting allows to initiate a measurement or a sequence by an externally generated trigger signal. You may however also add more input trigger steps to a sequence.***

iii. Arm the analyzer so that it triggers to an externally generated GlideSweep signal

→ *Refer to chapter 'External signal analysis'*

Measurement execution

As soon as the trigger impulse has been given, the FX100

1. generates the test signal (*exceptions*: the instrument has been armed, or the generator is muted),
2. samples the incoming signal, calculates the active measurement results and compares them against predefined tolerance limits in real-time,
3. uploads the result data to the controller PC.

NOTE **A measurement is only executed if a result display is placed on a Worksheet.**

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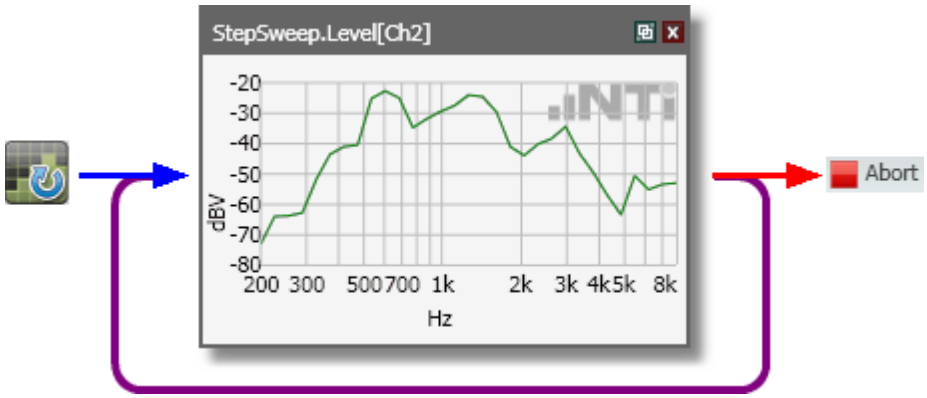
8.5.1 Continuous

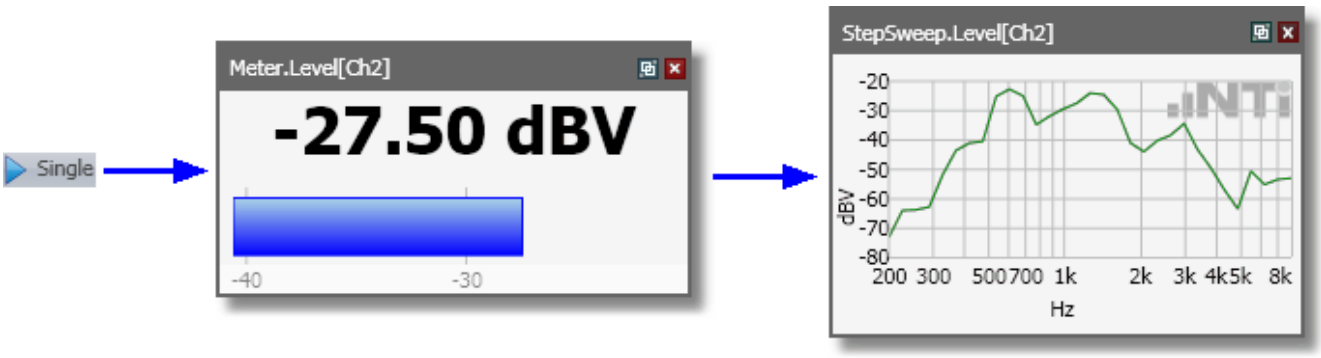
Click on the , or button in the 'Start' ribbon to initiate the continuous acquisition of the respective measurement (either Meter or StepSweep or GlideSweep mode).



Terminate the continuous measurement by clicking on the button.

8.5.2 Single

Click on the button in the 'Start' ribbon to initiate a single shot acquisition of all active measurements (Meter, StepSweep or GlideSweep mode).



The green button in the quick access toolbar or the <**F5**> key offer the same functionality for all FX100 Devices that are connected to the controller PC.

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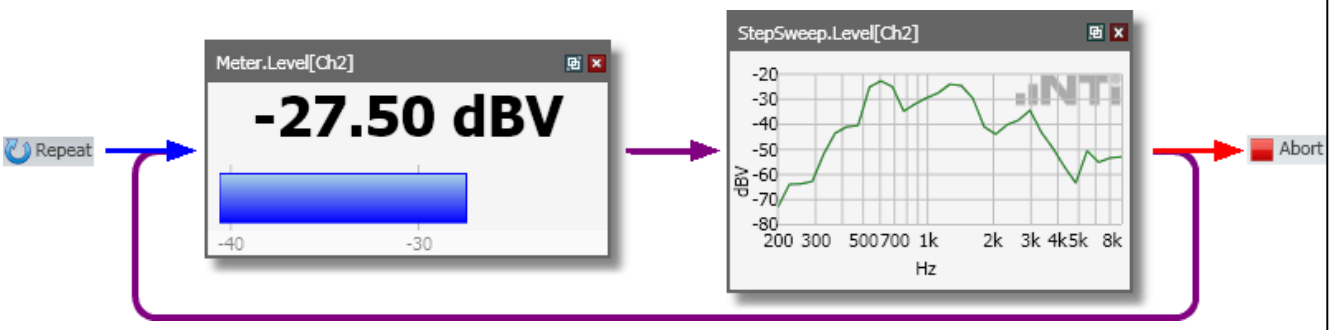
8.5.3 Repeat

Click on the Repeat button in the 'Start' ribbon to initiate the repeated acquisition of all active measurements (Meter, StepSweep or GlideSweep mode).



Terminate the repeat measurement by clicking on the Abort button.

The green button in the quick access toolbar or the <**F6**> key offer the same functionality for all FX100 Devices that are connected to the controller PC.

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8.6 Result display & data handling

The acquired measurement results can be visualized or processed in different ways.

- Display the Meter measurement results as numerical values or in a bargraph..
- Show the StepSweep, GlideSweep result curves in a graph.
- Compare the measurement results against customized tolerance limits and show the outcome in a PASS / FAIL display.
- Process the acquired measurement data with a user-defined calculation.
- Copy raw data to the clipboard (and paste, for example, to a spreadsheet)
- Log the acquired result data to a file.

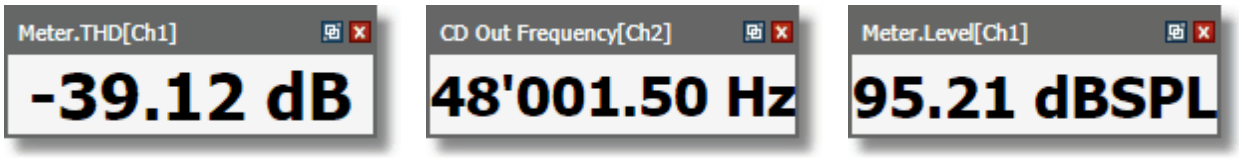
NOTE A measurement is only executed if a result display is placed on a Worksheet.

8.6.1 Numerical display

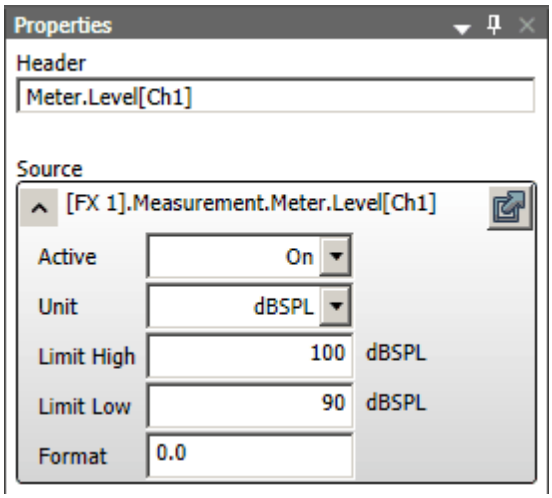
The numerical display can be used for all Meter mode measurements. To activate a measurement and to show the related numerical result display,

- drag & drop the icon of the corresponding measurement function from the tree to the Worksheet, or
- click on the 'Numeric Display' button in the worksheets ribbon and select the required measurement.

Examples



Hint ***Right-click on the meter display to***
- ***(de-)activate the measurement,***
- ***amend the measurement unit for the next cycle,***
- ***set the reference level for level relative measurements***



- Header → editable name of the numerical display
- Active → select "Off" to temporarily disable the measurement
- Unit → selectable measurement unit
- Limit High / Low → editable upper / lower tolerance limit
- Format → the format of the numerical readout, e.g.
  - "0.00" limits the number of digits behind the decimal separator of the measured result.
  - "e" shows the numerical result in exponential (i.e. scientific) notation. *Example: -61.96 dBV ⇒ "-6.196e+001 dBV"*

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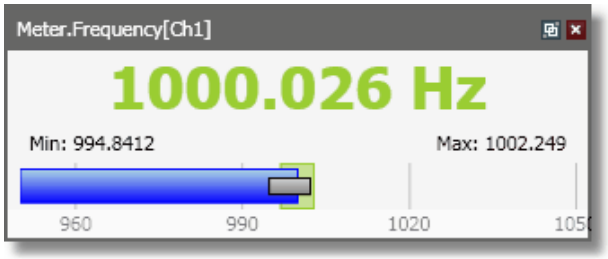
8.6.2 Bargraph

The bargraph display shows the numerical measurement next to a graphical indicator. To activate a measurement and to show the related bargraph result display,

- right-click on the icon of the corresponding measurement function in the tree, or
- click on the 'BarGraph Display' button in the worksheets ribbon and select the required measurement.

Example



Right-click on the bargraph to

i. (de-)activate the measurement
ii. amend the measurement unit,
iii. show the tolerance limit (green bar),
iv. show the min/max results numerically and graphically (grey bar),
v. reset the min/max results display,
vi. activate the auto scaling or edit the scaling manually.

Hint ***The numerical result will be shown in green or red ciphers, depending whether the measurement is within or beyond the tolerance limits.***

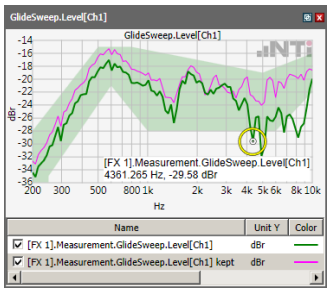
8.6.3 Graph

The acquired FFT or sweep measurement results are displayed as curves in a standard 'Line Graph' or a 'Line Graph Collector'.

NOTE **A graph can host the result curves of simultaneously acquired measurements (e.g. level chn1 and chn 2, or THD and Harmonics), but not of measurements with different Y-axis unit.**

A PASS/FAIL tolerance that is defined for a specific measurement applies on every line graph and line graph collector of the measurement.

Line Graph



Frequency response line graph with title, tolerance limits, kept curve, cursor readout and legend

The line graph displays the last recorded measurement curve, kept curves (optional) and with the active tolerance limits.

- Read out the data of any measurement point → move the cursor over the curve.
- Keep the last recorded curve → right-click on the curve and select "Keep Curve". Thus, the curve and the related data is saved
  - in the graph,
  - in the project file,
  - and as a calculation item.
- Delete a curve → right-click on the curve and select "Delete".
- Copy the numeric data of the last recorded or a kept curve to the clipboard (from where it can be pasted, for instance, to a spreadsheet program) → right-click on the curve and select "Copy Data".
- Amend the graph scaling → right-click on the graph and select "Edit Scale...", "Y Axis" or "X Axis".

NOTE **Be careful when changing the scaling from linear to logarithmic or vice versa, as this may compromise e.g. the result of a linear interpolation (refer to chapter X-/Y-axis scaling).**

- Show Title → adds the title of the measurement in the top line; the title is thus included if the graph is copied or exported to a report
- Show Legend → adds a section below the graph that shows the name(s), unit and color(s) of the displayed curve(s).

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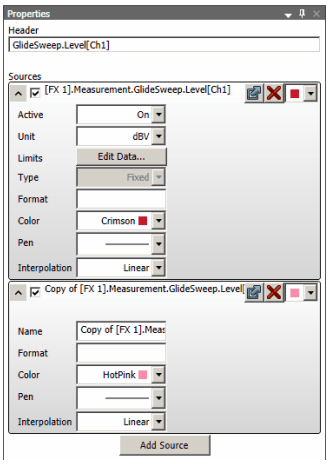
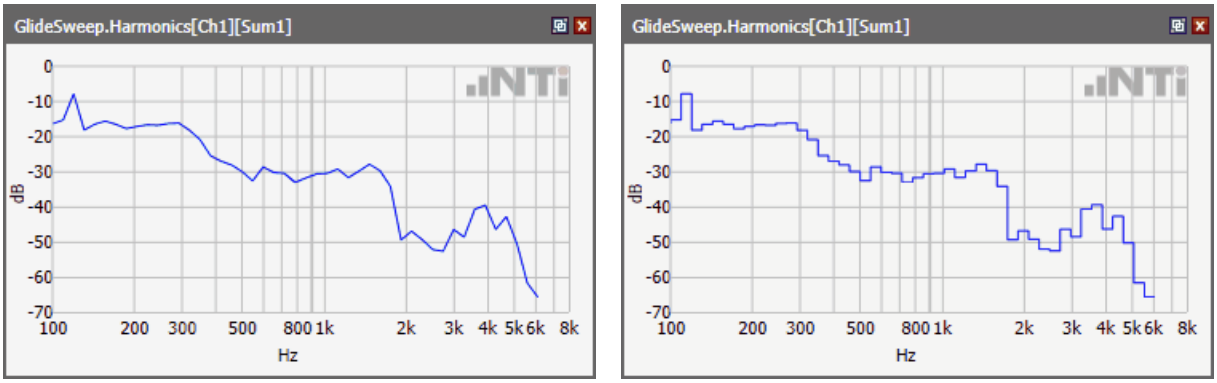
- Zoom in by moving the mouse over the area of interest while holding the left mouse button.
- Return to the full view by double-clicking on the graph with the left mouse button.



- Header → editable name of the line graph display
- Name (*applies only for kept curves*) → editable name of the corresponding kept curve
- Sources → measurement function.
  - Click on the button to activate another function.
  - Click on the button to delete the corresponding source.
  - Click on the button to amend the curve color.
- Active → select "Off" to temporarily disable the measurement
- Unit → selectable measurement unit (Y-axis)
- Limits: Edit Data... → edit the tolerance limits for the related measurement
- Type → (*not yet implemented*)
- Format → (*applies only for single-value results*)
- Color → selectable color of the corresponding curve
- Pen → selectable line style (stroke) of the corresponding curve
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Add Source → click on this button to select and place another measurement on the worksheet.



Example of harmonics line graph with linear (left) and stepwise (right) interpolation

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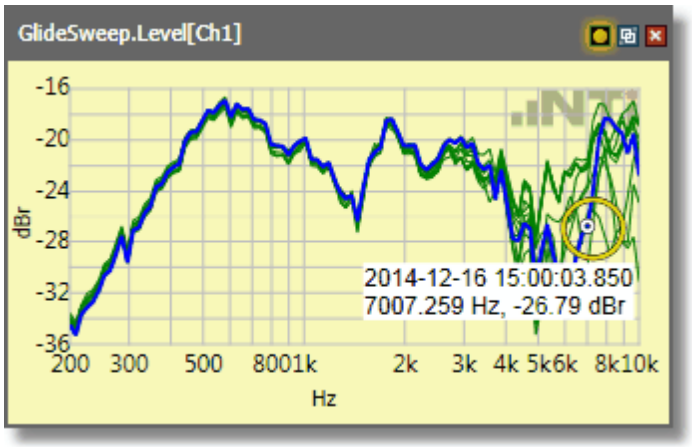
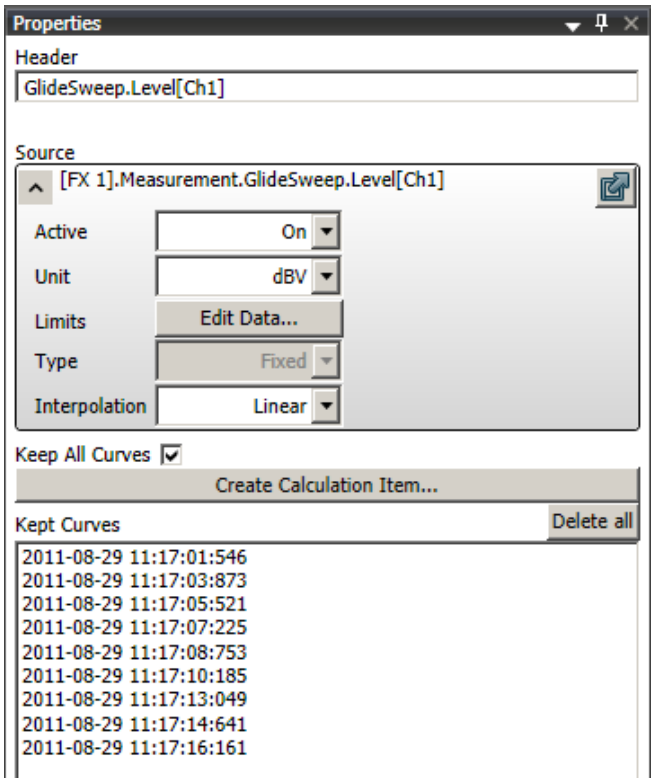
Line Graph Collector



The line graph collector automatically keeps and shows all acquired measurement curves.

- Highlight a specific curve → hover with the cursor over the curve of interest or select it via the properties (*see below*)
- Read out the data of any measurement point → hover with the cursor over the curve of interest (displayed in blue color).
- Keep a recorded curve to use it as calculation item → right-click on the curve and select "Keep Curve".
- To delete a specific or all curves,
  - right click on a curve and select "Delete", or
  - right click on the graph and select "Delete All curves".
- Temporarily disable the curve collection, while the measurement function stays active (i.e. every new curve is shown, but not kept) → right-click on the graph and de-select "Keep All Curves" (vice versa, tick the menu to re-activate the collection of curves).
- There are two ways to copy data from the graph to the clipboard *(refer also to the explanations below)*.
  a) Right-click on a curve and select "Copy Data" → copies the numerical data of that curve to the clipboard.
  b) Left-click on the button in the top bar of the graph → the numerical data of all curves and the graph itself (in bitmap format) are copied to the clipboard.
- Amend the graph scaling → right-click on the graph and select "Edit Scale...", "Y Axis" or "X Axis".
- Zoom in by moving the mouse over the area of interest while holding the left mouse button.
- Return to the full view by double-clicking on the graph with the left mouse button.



- Header → editable name of the line graph collector.
- Source Active
  - On → the collection of curves is active
  - Off → completely disables the curve collection (line graph collector becomes shaded = measurement inactive).
- Unit → selectable measurement unit (Y-axis).
- Limits: Edit Data... → edit the tolerance limits o for the related measurement.
- Type → (*not yet implemented*)
- Interpolation
  - Linear → the displayed result curve is drawn by connecting neighbored points directly via straight lines.
  - Steps → the displayed result curve is drawn by drawing horizontal lines between neighbored points.
- Keep All Curves
  - checkbox ticked → curve collection is active
  - checkbox cleared → the collection of curves is temporarily disabled, while the measurement function stays active (i.e. every new curve is shown, but not kept).

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- To use a specific or all collected curves as reference data for a calculation,
  - click on the "Create Calculation Item..." button → a panel opens to define the function and parameters of the required data processing (e.g. maximum data + 3 dB offset)
- To copy the numeric data of a specific curve to the clipboard, right-click on the curve in the list of kept curves and select "Copy Data" *(refer also to the explanations below)*.
- To delete a specific or all curves,
  - right-click on the specific curve in the list of kept curves and select "Delete",
  - click on the "Delete all" button to delete all collected curves at once.

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Post-processing of recorded curves

Copy data to the clipboard

a) Left-click on the button in the top bar of the graph display ⇒ copies all numerical data and the graph with all displayed curves to the clipboard

b) Right-click on a curve and select "Copy Data" ⇒ copies only the numerical data of the corresponding curve to the clipboard

Paste data from the clipboard

The contents that are pasted from the clipboard depend on the type of target program and the paste command.

	Paste command	
Target program	*a) press <Ctrl> + <V> button*	*b) use "paste special" feature*
Text editor	⇒ only numerical data	⇒ only numerical data
Spreadsheet[1] or desktop publishing[2] program	⇒ only numerical data	⇒ **numerical data and graph**
Image editor	⇒ only graph	⇒ only graph

[1]: e.g. MS Excel

[2]: e.g. MS Word

Hint ***Please refer also to the 'Full Resolution' results export feature***

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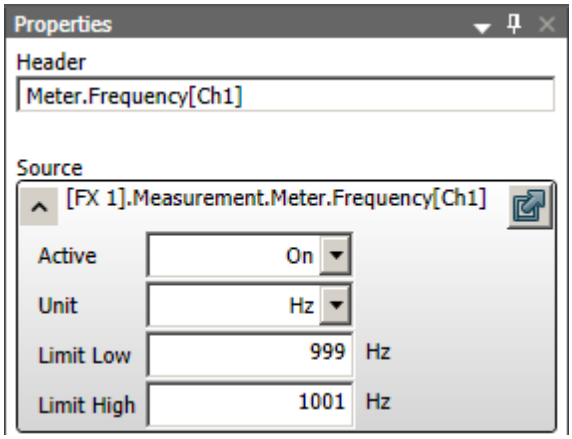
8.6.4 Passed/Failed display

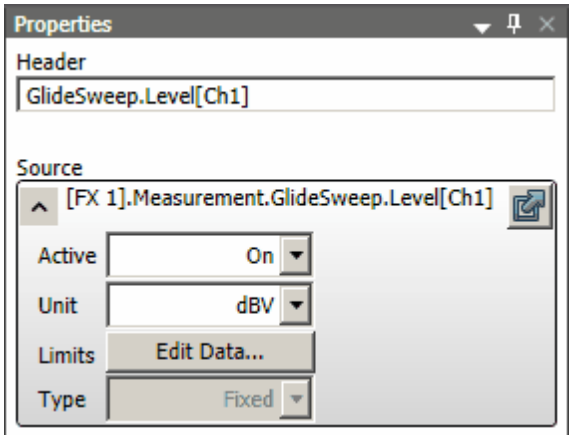
In order to add a PASSED / FAILED display, proceed as follows:

1. Activate or select the related measurement
2. Define appropriate tolerance limits for the measurement
3. Place the Passed/Failed display on the worksheet as follows: either
   - left-click on the button 'Passed/Failed display' in the Worksheets ribbon, or
   - right-click on the measurement function in the worksheets toolbox.

Properties



- Header → editable name of the Passed/Failed display
- Source → connected measurement function
- Active → switch to 'Off' to de-activate the measurement
- Unit
- Limit



NOTE With the calculations feature it is possible to combine the outcome of several measurements in an overall Passed/Failed display

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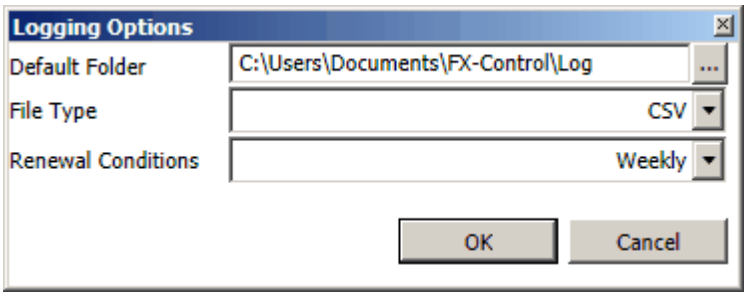
8.6.5 Data logging

FX-Control supports a comprehensive data logging feature that automatically saves the recorded measurement results to a file.

1. Click on the 'Enable' button in the Logging ribbon to enable the automated data logging
2. Adjust the logging settings via the corresponding button
   - Select the Default Folder
   - File Type
     - CSV → character-separated values
     - Text → tabbed text file
     - XLSx → compatible to MS XLSx format (*Note: this logging format may slow down the process*)
   - Renewal Conditions
     - Never → all measurement results are saved to a single file
     - Weekly → a new target file is opened at the beginning of a new calendar week
     - Daily → a new target file is opened at the beginning of every new day
     - At Each Measurement → the result data of every measurement cycle is written to an individual file



Example

Logged frequency response data imported to MS Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	High Limit																		
2	X	50.845095	70.816996	98.633839	592.53811	983.51493	1680.8992	8149.4393	10000										
3	Y	-59.738688	-70.576512	-60.099949	-24.69639	-24.69639	-34.811693	-17.832435	-18.916218										
4	Low Limit																		
5	X	49.371723	58.374843	79.228752	130.95592	794.74885	1714.0057	9804.8618											
6	Y	-90.294674	-90.294674	-95.418934	-74.921896	-37.258588	-49.556811	-33.415393											
7	Date	Time	Passed	Attribute	Hz	10000	8381.061	7024.218	5887.04	4933.964	4135.186	3465.724	2904.645	2434.4	2040.286	1709.976	1433.141	1201.124	10(
8	31.08.2011	09:01:56	True		dBV	-24.2531	-27.01291	-26.85214	-34.10651	-36.24038	-37.75914	-36.35818	-37.34245	-38.17021	-42.84995	-43.50687	-41.09671	-36.17632	-31.5
9	31.08.2011	09:01:57	True		dBV	-23.92147	-27.11607	-26.8135	-33.54108	-36.27518	-37.48169	-36.31651	-37.25029	-38.10445	-42.56673	-43.70897	-41.16999	-36.17455	-31.5
10	31.08.2011	09:01:59	True		dBV	-23.88887	-26.98136	-26.82803	-33.45423	-36.33029	-37.36399	-36.43692	-37.31589	-38.19287	-42.29685	-43.91365	-41.19406	-36.31249	-31.7
11	31.08.2011	09:02:00	True		dBV	-23.9635	-26.93162	-26.79131	-33.47871	-36.3103	-37.58455	-36.56578	-37.39653	-37.95702	-42.51839	-43.85368	-41.19267	-36.1671	-31.6
12	31.08.2011	09:02:02	True		dBV	-24.64882	-26.61016	-27.0535	-33.64802	-36.14341	-37.94062	-36.77507	-37.67168	-38.38971	-43.02881	-43.97227	-41.43904	-36.36524	-31.7
13	31.08.2011	09:02:04	True		dBV	-26.78595	-26.2291	-27.50834	-34.22744	-35.64126	-39.0766	-37.25229	-38.2247	-39.66695	-44.92006	-45.33693	-41.91328	-36.63902	-32.4
14	31.08.2011	09:02:06	True		dBV	-22.36574	-24.00693	-25.42662	-31.27766	-35.9626	-35.12169	-34.6481	-35.1968	-35.1674	-38.25442	-39.78781	-38.22513	-34.94098	-30.0
15	31.08.2011	09:02:08	True		dBV	-21.27982	-22.0968	-25.08478	-30.21097	-34.75005	-34.14268	-33.92131	-34.35487	-34.33475	-36.80542	-38.13725	-36.83085	-34.22711	-29.3
16	31.08.2011	09:02:10	False		dBV	-28.85293	-25.23369	-33.12839	-43.33606	-36.11256	-45.76366	-41.53176	-42.44991	-47.68998	-56.51697	-47.31526	-41.24718	-37.43142	-35.1
17	31.08.2011	09:02:12	False		dBV	-30.5319	-25.49617	-30.68633	-39.92889	-34.85528	-42.57244	-39.30017	-39.96477	-43.16287	-49.75663	-46.5234	-42.48111	-37.02929	-33.6
18	31.08.2011	09:02:14	True		dBV	-29.75071	-26.00326	-29.4027	-37.04592	-34.83775	-40.86817	-38.20102	-39.1599	-40.81647	-47.17939	-45.91252	-42.32384	-36.91364	-33.3
19	31.08.2011	09:02:16	False		dBV	-28.37752	-26.53285	-28.38355	-35.92878	-35.04484	-39.98827	-37.72191	-38.79346	-40.60194	-46.16201	-45.33184	-42.13924	-36.31488	-32.6
20																			
21																			

NOTE Please refer also to chapters Full resolution data, States and Template for build report for an alternative data logging method.

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8.6.6 Full resolution results

FX100 allows to store full resolution data on the controller PC (i.e. all samples that were acquired during the measurement process). The Full Resolution upload capabilities are supported in the Meter or GlideSweep mode, single or repeat measurements, and following functions.

- Meter mode
  - Frequency domain (i.e. FFT spectrum)
  - Time domain (i.e. FFT scope recording)
- GlideSweep mode
  - Impulse response
  - Energy-Time Curve

Depending on the measurement function, the full resolution data can thereby be saved in four different file formats.

i. CSV: comma-separated values

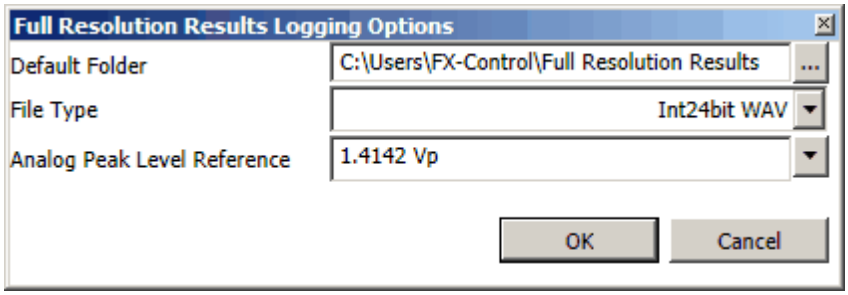
ii. Text: tabbed text

iii. Matlab: *.MAT file (including variables)

iv. WAV: integer @ 24 bit resolution, or floating point @ 32 bit resolution

Procedure

a) Adjust the 'Full Resolution Result Logging Options'
   - Select the Default Folder
   - File Type
     - CSV → character-separated values
     - Text → tabbed text file
     - Matlab → *.MAT file for direct import into the MATLAB software
     - Int24bit WAV → integer WAV file @ 24 bit resolution
     - Float WAV → float WAV file @ 32 bit resolution
   - Adjust the Analog Peak Level Reference (only required for WAV files) → The maximum allowed input level, i.e. if the incoming signal shows a higher level, clipping occurs in the WAV file.



b) Activate the measurement(s) of interest, i.e. drag & drop them to the 'Worksheet'.
   - FFT in Domain "Time" or "Frequency"
   - GlideSweep Impulse response or ETC

c) Activate the 'Write Full Res. Results to File' in the properties of the corresponding measurement.

d) Initiate the measurement(s); the system will consequently
   1. sample the data
   2. calculate & display the acquired results
   3. transfer the full resolution data to the target file

NOTE Full Resolution results are not available for continuous measurements

Hint The data transfer of a full resolution data file to the controller PC may take a couple of seconds.

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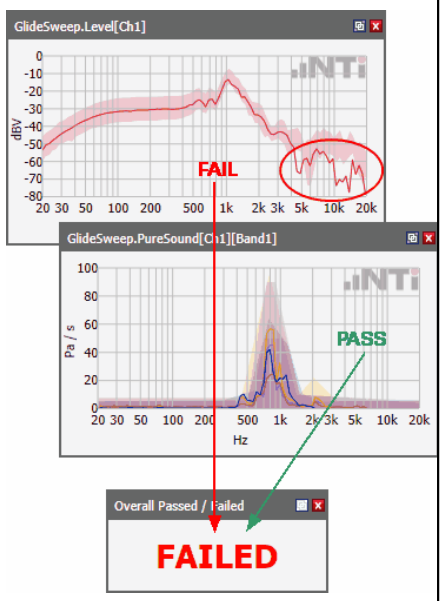
8.7 Calculations

The calculations feature is a powerful tool for processing acquired data in various ways and creating new, customized analyses.

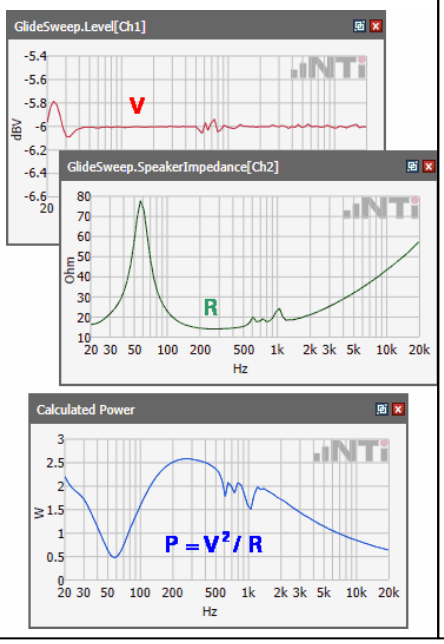
A calculation typically comprises different elements, such as single or combined measurement results, mathematical formulas, unit conversions etc.

Examples

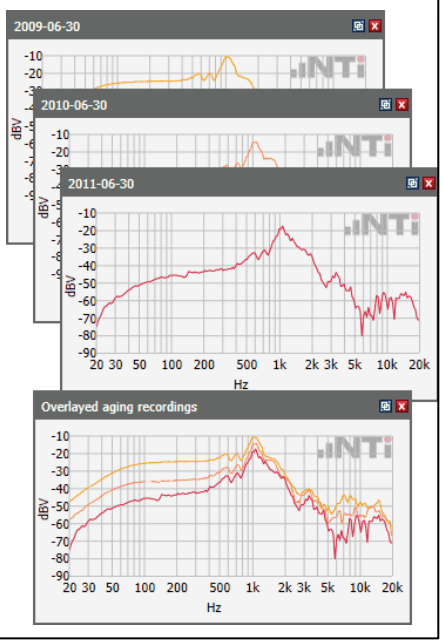
Overall Passed/Failed



Calculated power



Aging process recording



How to create a calculation

1. Establish the test setup and reproduce it in the Hardware & Wiring view.
2. Activate & record the required measurements and tolerance limits.
3. Add the required standard or generic calculation items.
4. Define the calculation with these calculation items and the required mathematical operators.
5. If required, define & apply individual tolerance limits for the calculation item.

NOTE Before a calculation can be established, the required calculation items have to be defined.

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8.7.1 Calculation items

There are three classes of calculation items.

Kept curves	*Generic calculation item*	*Default calculation items*
Manually kept curves from an executed StepSweep or GlideSweep measurement.	A calculation item that contains and executes a user-defined formula.	• Calculated Passed/Failed • Overall Passed/Failed • Unit Converter • Linear Interpolation • Smoothing • Relative Response • Previous Result • Linear Fit • Sample Rate Deviation

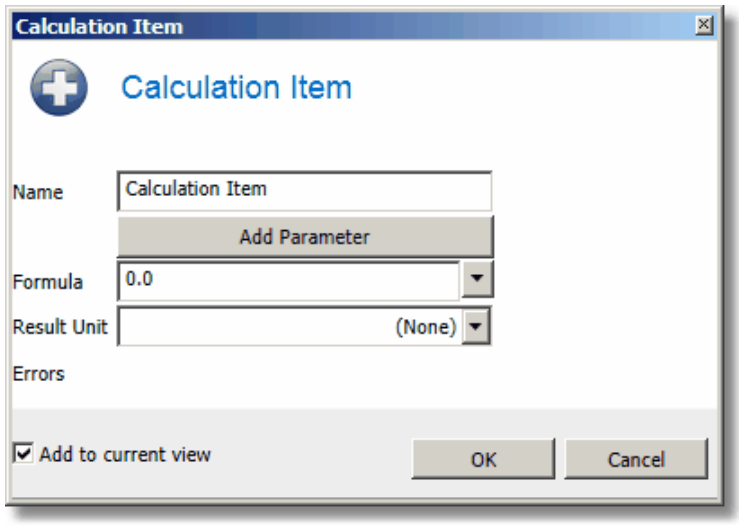
Hint ***All defined (i.e. available) calculation items are listed in alphabetical order the worksheets toolbox. Thus, you may group the items according to your demands by editing their names.***

Please refer to chapter 'Calculation example' for further details.

Generic calculation item

Step 1 - Open the 'Calculation Item' panel

Click on the 'New Calculation' button in the worksheets ribbon to open the 'Calculation Item' dialog box.



If desired, edit the name of the generic calculation item (*optional*)

Step 2 - Select a source

Click on the 'Add Parameter' and select the data source for the generic calculation item, e.g.

- an already active or a new measurement
- a calculation item that has already been defined

Hint ***The 'Tree' comprises all measurement functions and existing calculation items, whereas the alternate tab lists only measurement functions.***

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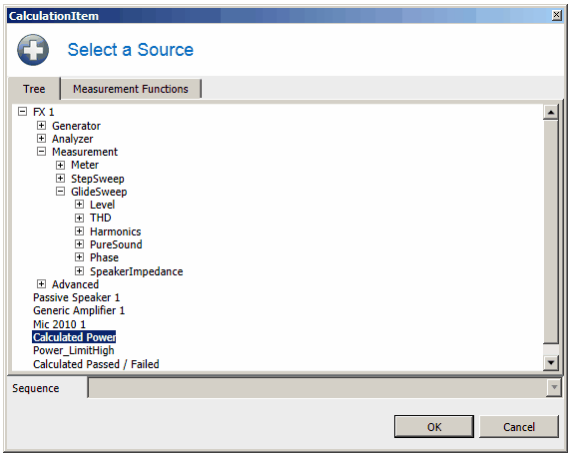
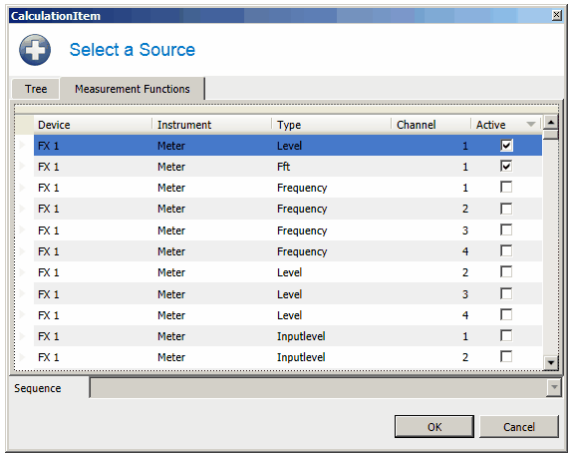
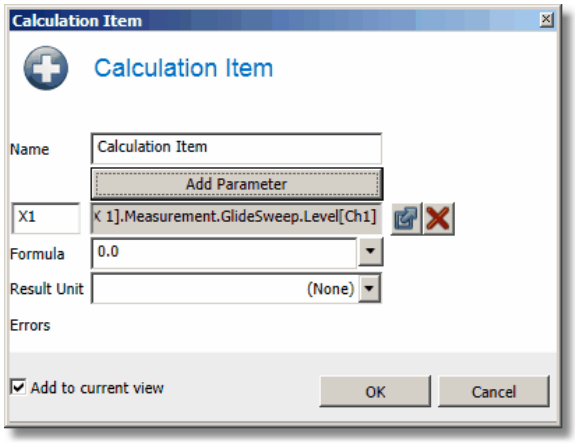




Consequently, the selected data source is added to the 'Calculation Item' dialog



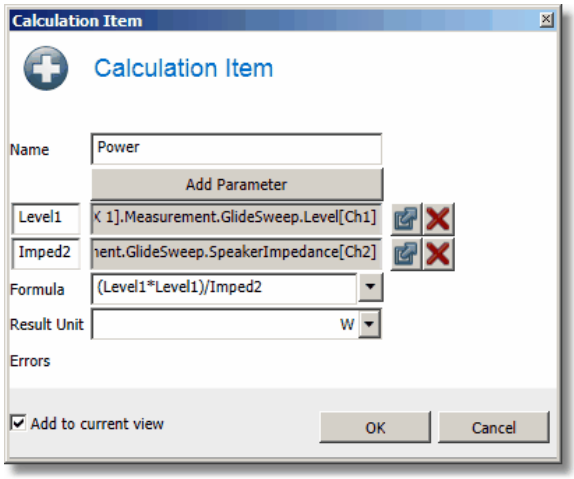
If desired, amend the name of the new data source (*e.g. 'X1' -> 'Level1'*)

Add further data sources according to your requirements.

Step 3 - Define the calculation instruction

Define the formula that processes the data sources with

- mathematical operators,
- boolean operators or
- specific operators of FX-Control.



Assign an appropriate result unit of measurement to the new calculation item.

If the formula is incorrect, an error message will appear.

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Special hint – Calculation of curves

If two or more curves shall go into the same calculation, they first have to be aligned regarding their X-values (i.e. number of points, spacing). This alignment is done as follows.

- Master curve: X1
- Slave curve: X2
- Command: X2.LinearInterpolation(X1)
- Effect: the X-axis points of curve X2 are aligned to the X-axis points of curve X1 (via linear interpolation)

Hint The interpolation is by default carried out logarithmically on the x-axis, and linearly on the y-axis.

The interpolation of the X/Y-axis can also be carried out in a different way via the following parameters.

a) Xlog/Ylin: X2.LinearInterpolation(X1, eTolInterpolationType.Logarithmic, eTolInterpolationType.Linear)

b) Xlog/Ylog: X2.LinearInterpolation(X1, eTolInterpolationType.Logarithmic, eTolInterpolationType.Logarithmic)

c) Xlin/Ylog: X2.LinearInterpolation(X1, eTolInterpolationType.Linear, eTolInterpolationType.Logarithmic)

d) Xlin/Ylin: X2.LinearInterpolation(X1, eTolInterpolationType.Linear, eTolInterpolationType.Linear)

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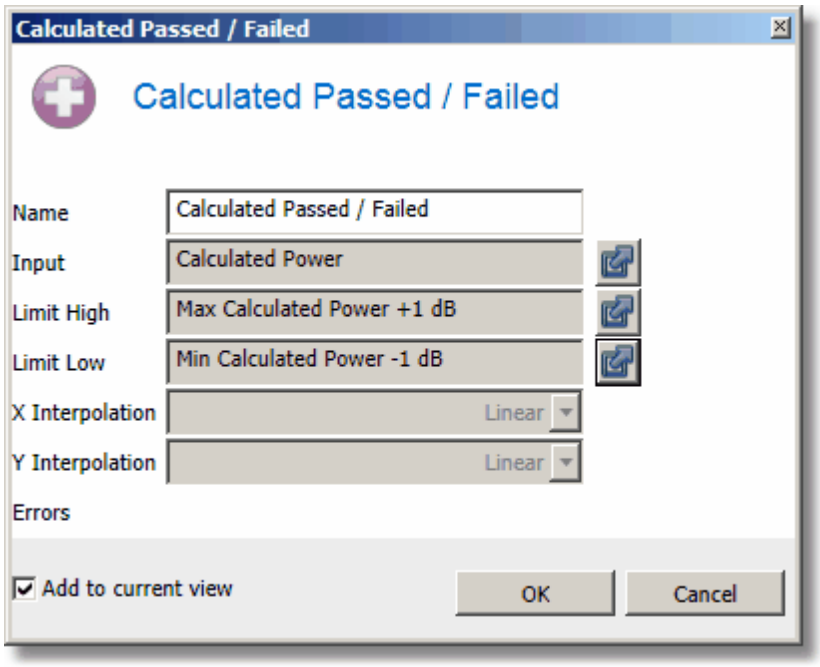
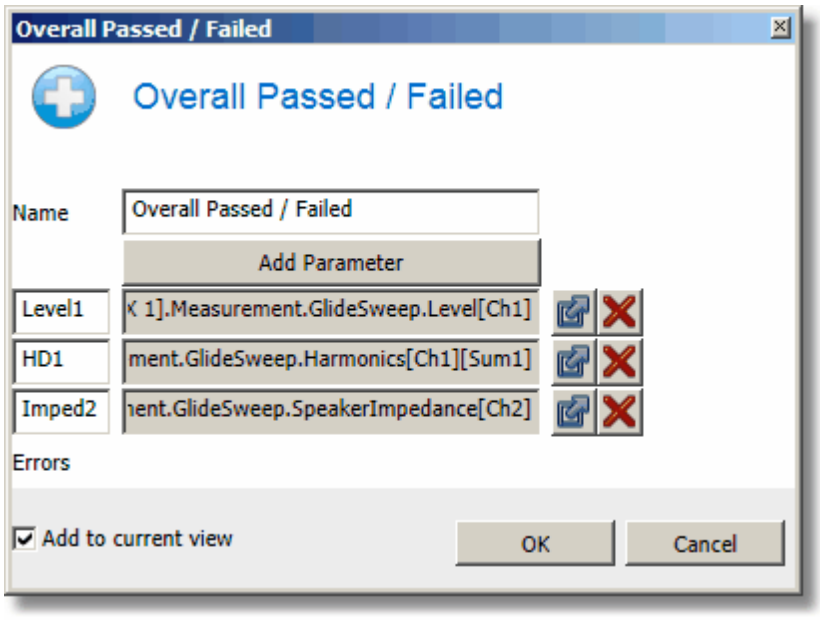
Default calculation items

Hint ***The term 'Input' hereunder refers to***
- ***acquired measurement results (single values or curves)***
- ***the output (result) of another calculation item***

Item	*Example*
Calculated Passed / Failed Checks the input of the calculation item against generic tolerance limits. **NOTE** **The generic tolerance limits must be defined before the Calculated Passed / Failed item is added.**	
Overall Passed / Failed Checks, whether all input parameters (i.e. results of the selected items) are Passed; if one or more results are Failed, the overall result is Failed, too.	

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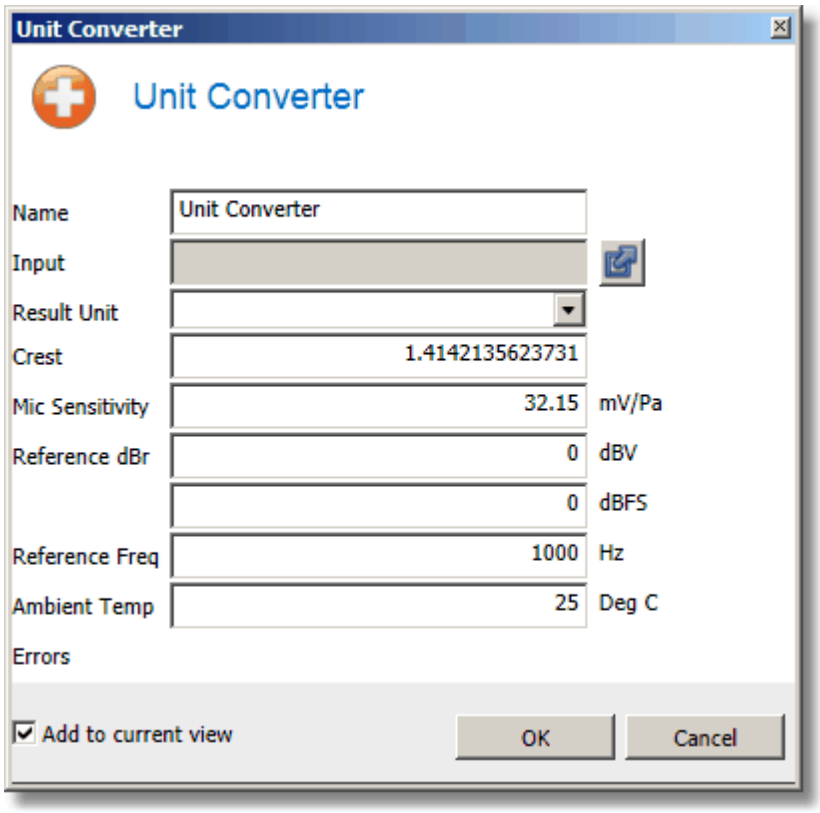
Unit Converter

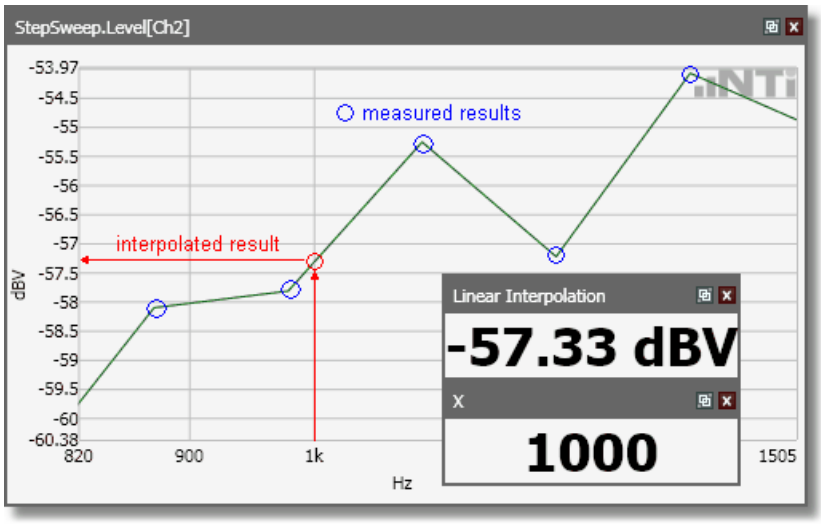
Opens a panel that allows to convert the unit of an acquired measurement; the panel includes the available constants that may be used for the calculation (e.g. for converting the acoustic signal run-time into distance by considering the ambient temperature).



Linear Interpolation

Interpolates the Y-value of the measured curve at an user-defined point of the X-axis.

NOTE **The linear interpolation is executed graphically – the scaling of the X-, Y-axis (linear or logarithmic) therefore has a direct impact on the result.**



The interpolated level @ 1 kHz of the recorded curve = -57.33 dBV

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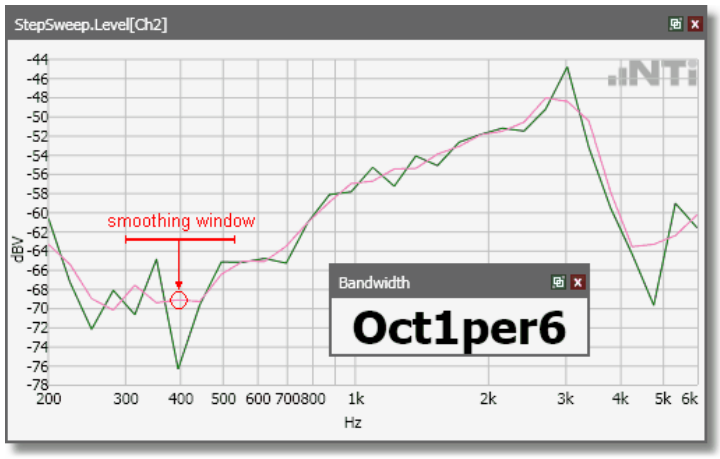
Smoothing

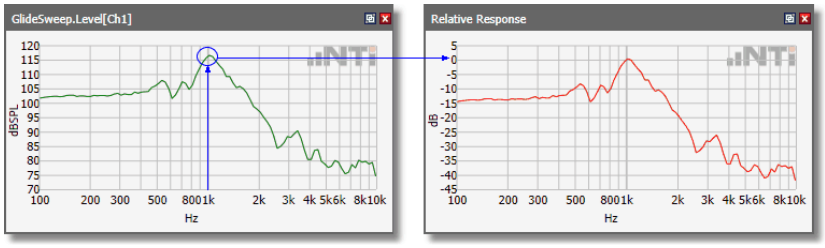
Flattens the measurement curve by averaging the acquired results within a window that has a user-defined width.



Green curve: original measurements / Pink curve: smoothed result curve (1/6th Octave smoothing window)

Relative Response

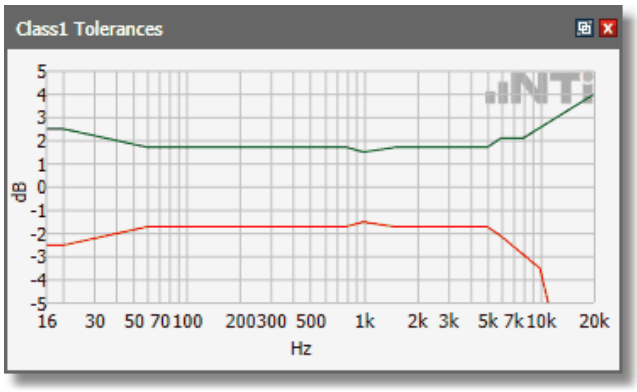
Plots the acquired result curve relative in dB to the Y-value of a reference point at an user-defined X-value



Green: absolute results / Red: results relative to 0 dB @ 1 kHz

Custom Curve

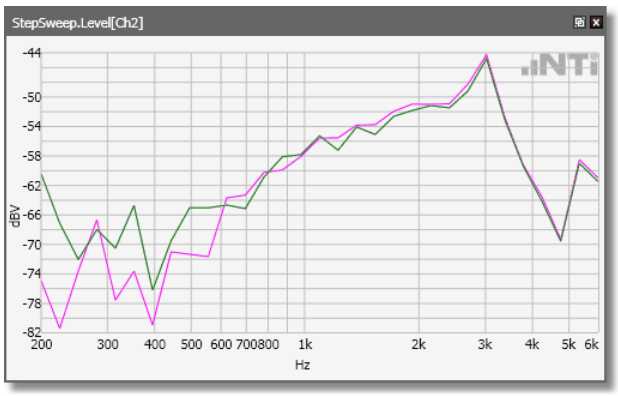
Creates a user-defined curve, that can be used e.g. as generic tolerance limit for Calculated Passed / Failed items, or as a 'golden' reference curve for deviation measurements.



Green, red curves: user-defined custom curves

Previous Result

Shows the last-but-one result curve; the previous result curve can be shown in the same graph as the last (i.e. actual) result curve, or in a separate graph.



Green curve: last (i.e. current) measurement / Pink curve: last-but-one measurement

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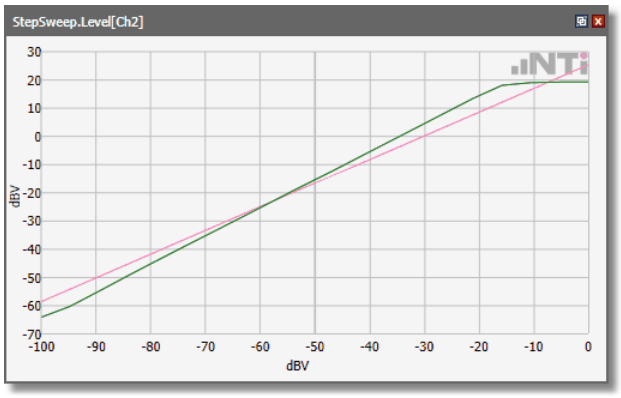
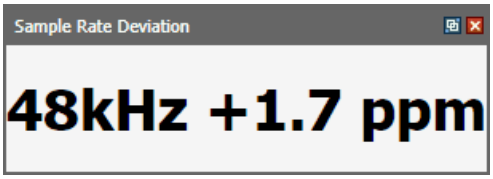
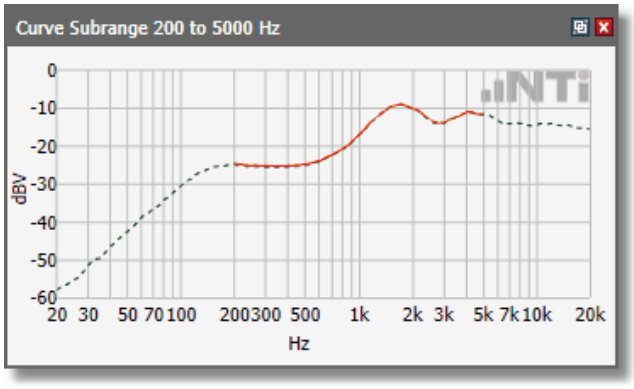
Linear Fit Calculates a straight line that represents the optimum linear fit to the measured curve.	 *Green curve: amplitude sweep result / Pink curve: linear fit*
Sample Rate Deviation Shows the deviation of the sample rate, measured versus the standardized digital sampling rates, whereby the input must be one of the following measurements • Frequency • AES input sample rate • Sync input sample rate **NOTE The frequency measurement must be expressed in [Hz]**	 *Deviation vs. 48 kHz sample rate* *(standard digital sampling frequencies are 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, 192 kHz)*
Curve Subrange Extracts the data of a restricted, user-defined frequency band from within the full range of measured results.	 *Green dotted curve: measured results / Red curve: selected subrange 200 Hz – 5 kHz*

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8.7.2 Operators, units

Mathematical

+	plus
-	minus
*	multiply by
/	divide by

Boolean

<	smaller than
<=	smaller than or equal to
>	larger than
>=	larger than or equal to
&	and
AND(a,b)	and
|	or
OR(a,b)	or
!	not
NOT(a)	not

Functions

Acronym	*Description*	*Mathematical formula*
adB	Inverse decibel function	$y = adB(x)$: $y = 10^{\frac{x}{20}}$
Abs	Absolute value	$y = Abs(x)$: $y = \lvert x \rvert$
dB	Decibel function	$y = dB(x)$: $y = 20 * \log_{10}(x)$
Exp	Exponential function	$y = Exp(x)$: $y = e^x$
Log	Natural logarithm	$y = Log(x)$: $y = \log_e(x)$
Log10	Logarithm to the base 10	$y = Log10(x)$: $y = \log_{10}(x)$
Max *	Maximum value	
Mean *	Arithmetic mean value	$y = Mean(x)$: $y = \frac{x_1 + x_2 + \cdots + x_n}{n}$
Min *	Minimum value	
Pow	to the Power of	$y = Pow(a,b)$: $y = a^b$
Rms *	Root mean square	$y = Rms(x)$: $y = \sqrt{\frac{x_1^2 + x_2^2 + \cdots + x_n^2}{n}}$
Rss *	Root sum square (quadratic sum)	$y = Rss(x)$: $y = \sqrt{x_1^2 + x_2^2 + x_3^2 + \ldots}$
Sqrt	Square root	$y = Sqrt(x)$: $y = \sqrt{x}$
Sigma *	Standard deviation (n)	$y = Sigma(x)$: $y = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}$
Stdev *	Standard deviation (n – 1)	$y = Stdev(x)$: $y = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2}$
Sum *	Arithmetic sum	$y = Sum(x)$: $y = x_1 + x_2 + x_3 + \ldots$

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*: Calculations that can have either a scalar or vector input parameter (scalar "x", e.g. level result – vector "$\underline{X}$", e.g. frequency response)

a. if the input parameters are two scalars, the result is a scalar: y = func(x_1,x_2)
b. if the input parameter is a vector, the result is a scalar: y = func($\underline{X}$)
c. if the input parameters are vectors, the result is a vector: $\underline{Y}$ = func ($\underline{X}_1$,$\underline{X}_2$,...$\underline{X}_n$)

Calculation Result Units

Unit	*Measurement*	*Comment*
A	Current	I [A] = Volt / Impedance
dB	Decibel	20*log(V_1 / V_2)
dBPa	Sound pressure	Sound pressure relative to 1 Pascal
dBu	Level	Voltage relative to 0.775 V
dBup	Peak level	Peak voltage relative to 0.775 V
dBV	Level	Voltage relative to 1 V
dBV / Pa	Microphone sensitivity	
dBVp	Peak level	Peak voltage relative to 1 V
deg	Phase	0°...360°
Deg C	Temperature	Centigrade
Hz	Frequency	
mV / Pa	Microphone sensitivity	
Ohm	Impedance	
Pa / s	PureSound steepness	Pascal per second
%	Distortion, XTalk	
%Tol		this unit is used for calculated tolerance limits
rad	Phase	-π...+π
s	Time	
V	Level	
V / s	PureSound steepness	Volt per second
Vp	Peak level	
W	Power	Power [W] = $Volt^2$ / Impedance

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8.7.3 Calculation examples

The following application examples demonstrate the process of establishing a calculation.

Hint ***Please refer also to chapter 'Sequences'***

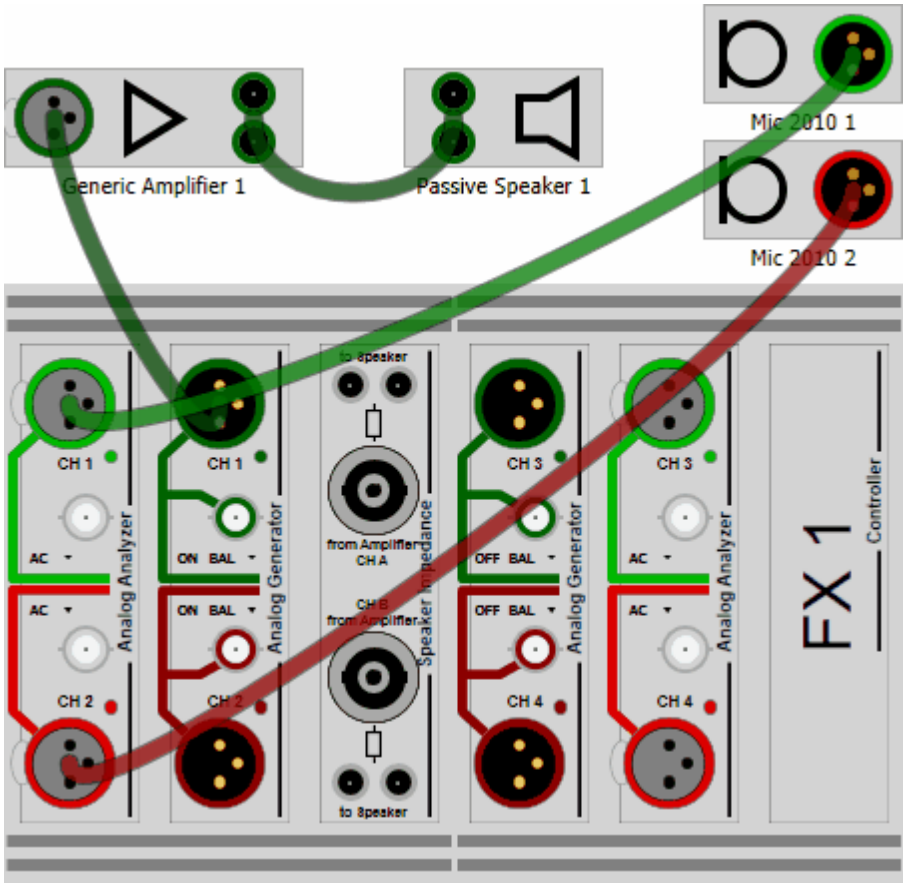
Example 1 – Difference between two measurement curves

Calculate the difference between two frequency response curves that have been acquired at different microphone positions.

Δ = Curve1 - Curve2

Step 1 - Test setup

Establish the internal and external connections between the FX100 instrument, the DUT (Device Under Test) and the two microphones.



Step 2 - Adjust the test parameters

- Enter the appropriate generator, analyzer settings (e.g. GlideSweep output level & input range)
- Activate the required measurements (i.e. chn1 level; chn2 level)

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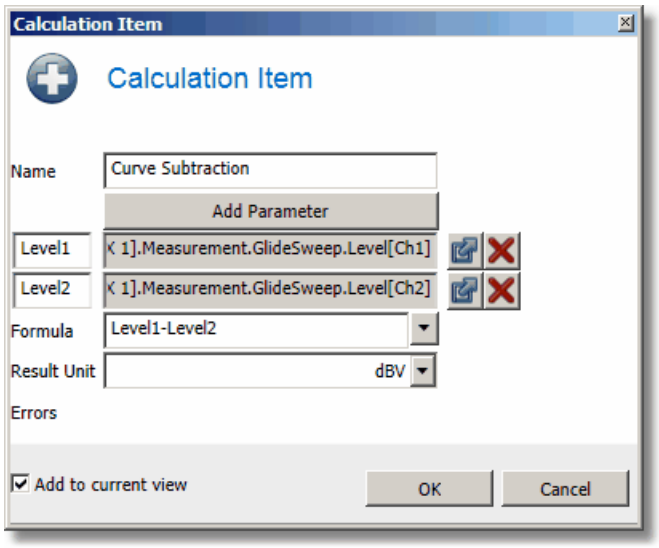
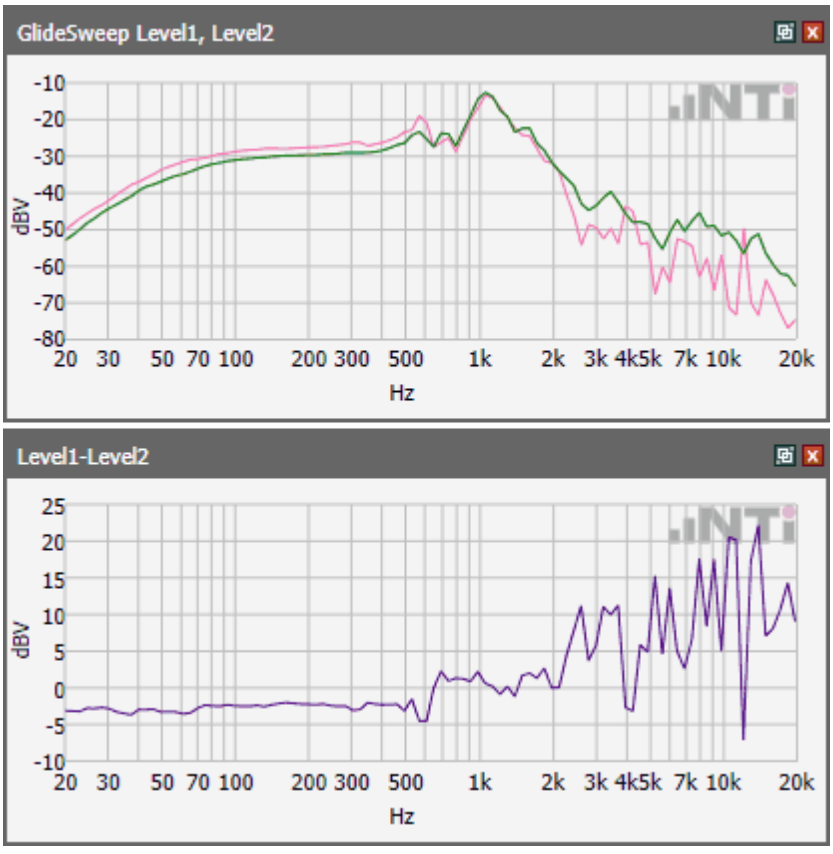
Step 3 - Establish the calculation

- Click on the 'New calculation' button in the worksheets ribbon.
- Add the level, impedance measurements as data sources.
- Enter the formula that calculates the difference: "Level1-Level2".
- Assign the measurement unit 'dBV' to the calculated result.



⇒ Consequently, a result display is opened on the worksheet that shows the calculated difference.



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Example 2 – Power consumption of a DUT

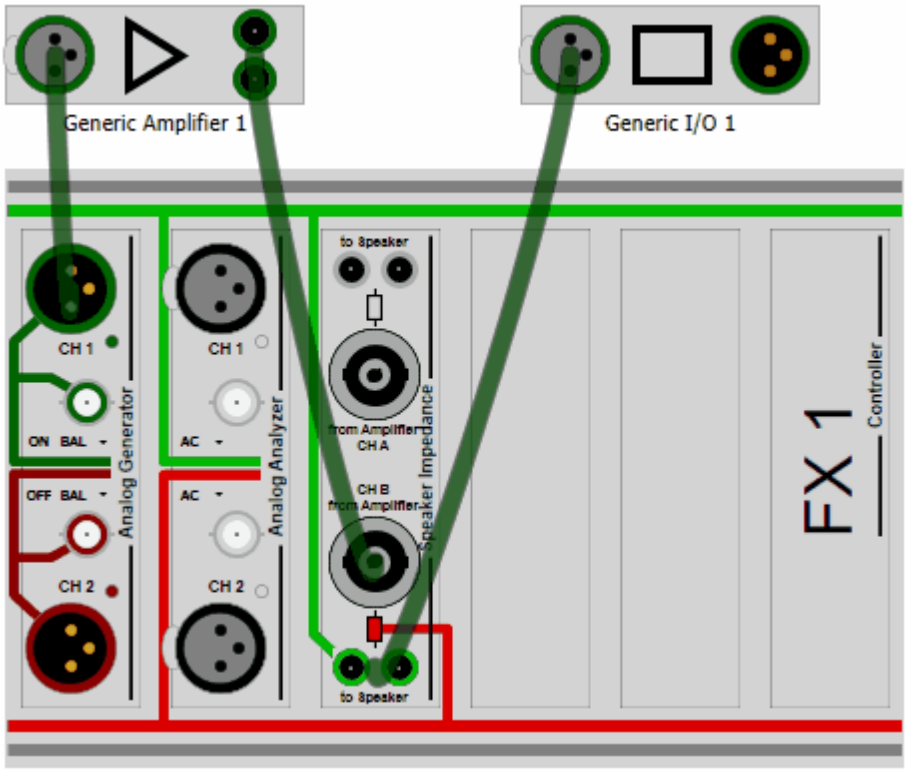
Measuring the power consumption of a DUT by using the formula P [W] = U^2 / R

U = voltage at the DUT input connectors

R = impedance of the DUT

Step 1 - Test setup

Establish the internal and external connections between the FX100 instrument and the DUT.



Step 2 - Adjust the test parameters

- Enter the appropriate generator, analyzer settings (e.g. GlideSweep output level & input range)
- Activate the required measurements (i.e. chn1 level; chn2 speaker impedance)

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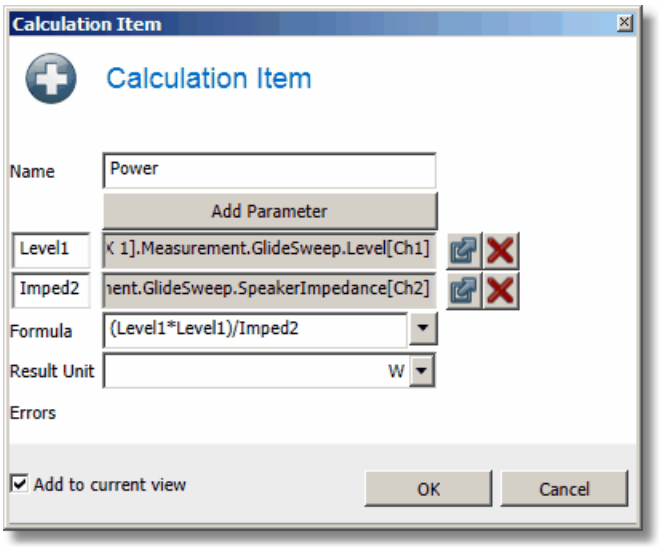
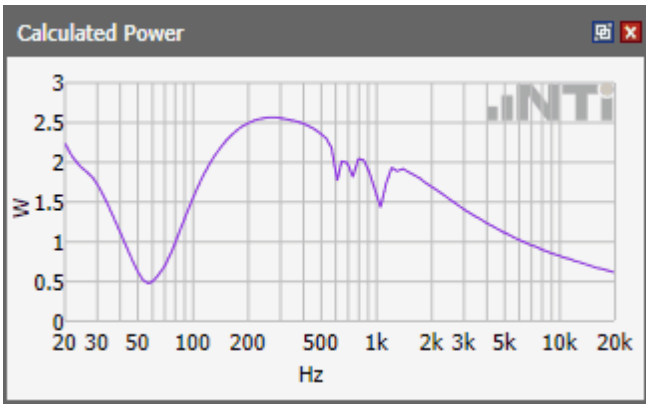
Step 3 - Establish the calculation

- Click on the 'New calculation' button in the worksheets ribbon.
- Add the level, impedance measurements as data sources.
- Enter the formula that calculates the power: "(Level1*Level1)/Imped2"
- Assign the measurement unit 'W' to the calculated result.



⇒ Consequently, a result display is opened on the worksheet that shows the calculated power curve.



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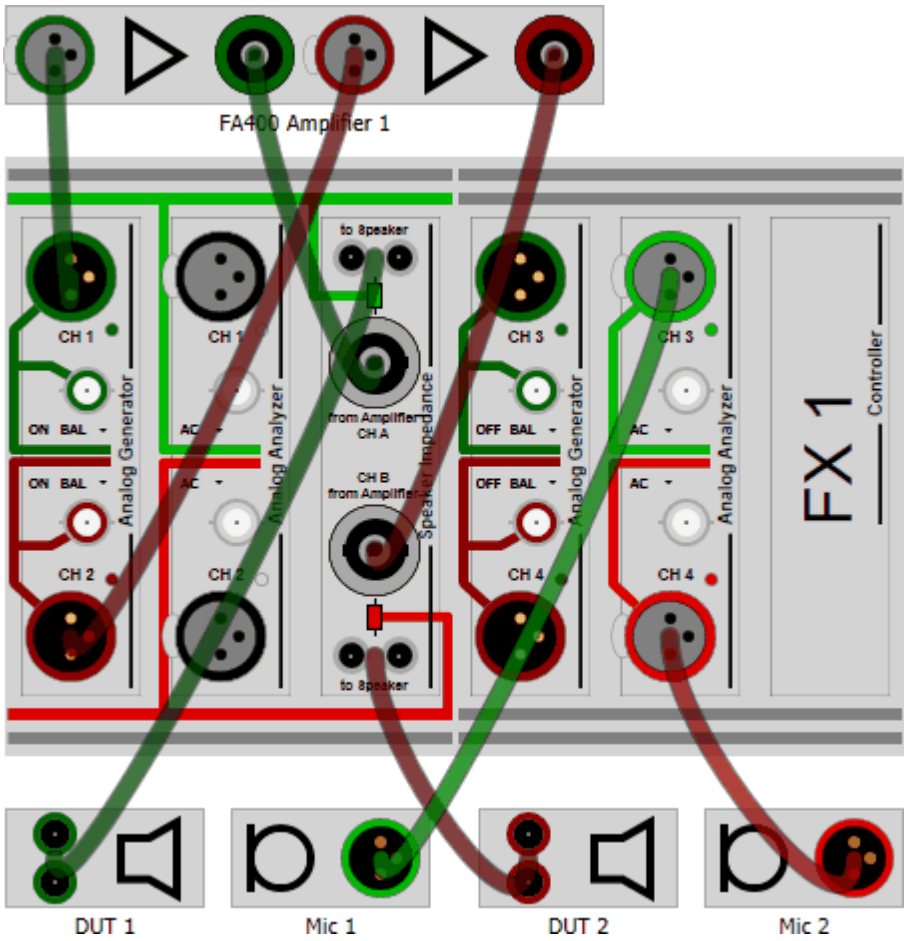
Example 3 – Stereo headphone qualification

The application verifies, whether the left and the right speakers of a headphone match to each other. The test measures the frequency response of the two channels and compares the acquired results to each other by calculating

- the SPL of both speakers @ 1 kHz,
- the deviation in the frequency response.

Step 1 - Test setup

a. Establish the internal and external connections between the FX100 instrument and the DUT.



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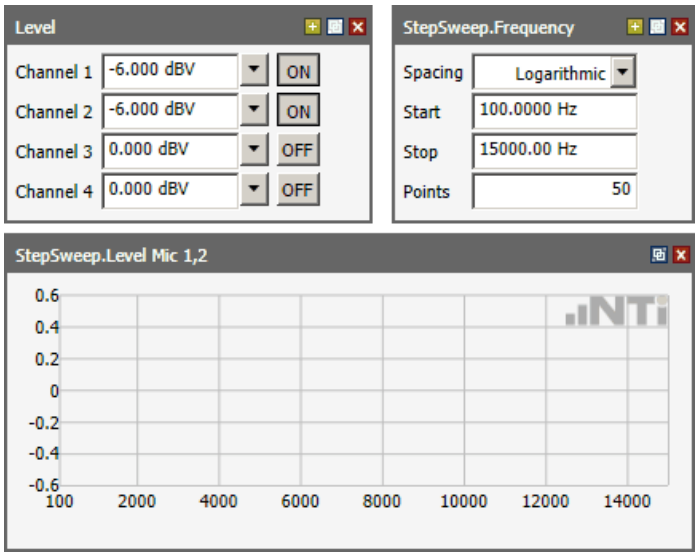
Step 2 - Adjust the test parameters

b. Enter the appropriate generator, analyzer settings (e.g. StepSweep bandwidth, output level)

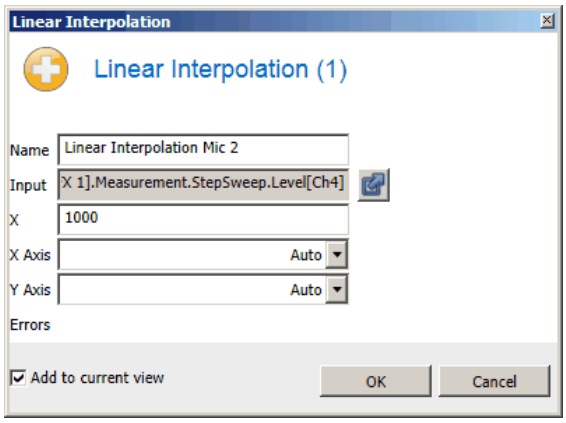
c. Activate the required measurements (i.e. chn1/2 speaker impedance, chn3/4 level)



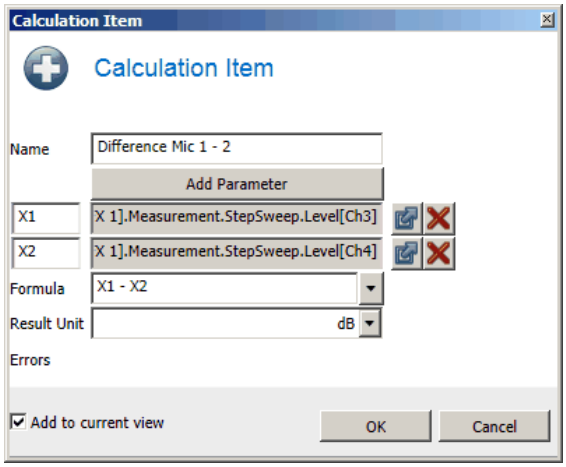
Step 3 - Establish the calculations

d. Click on the 'Linear interpolation' button in the worksheets ribbon and select the input: Measurement → StepSweep → Level Channel 3.

e. Repeat step d. for Channel 4



f. Click on 'New Calculation', select the input parameters Measurement → StepSweep → Level Channel 3, edit the calculation formula "X1 - X2" and select the result unit [dB].



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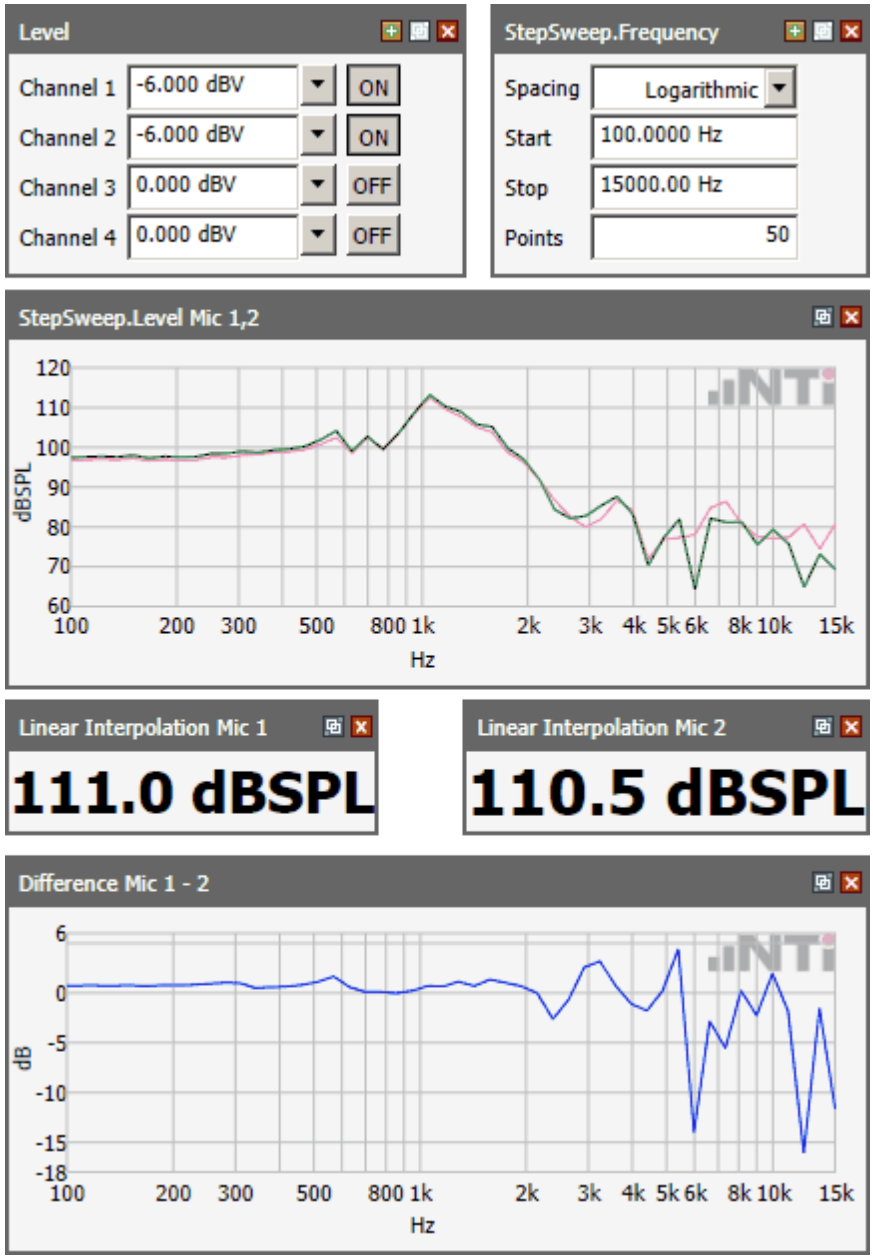
g. Run the measurement.


Level
Channel 1 -6.000 dBV ON
Channel 2 -6.000 dBV ON
Channel 3 0.000 dBV OFF
Channel 4 0.000 dBV OFF
StepSweep.Frequency
Spacing Logarithmic
Start 100.0000 Hz
Stop 15000.00 Hz
Points 50
StepSweep.Level Mic 1,2
dBSPL
120 110 100 90 80 70 60
100 200 300 500 800 1k 2k 3k 4k 5k 6k 8k 10k 15k
Hz
Linear Interpolation Mic 1
111.0 dBSPL
Linear Interpolation Mic 2
110.5 dBSPL
Difference Mic 1 - 2
dB
6 0 -5 -10 -15 -18
100 200 300 500 800 1k 2k 3k 4k 5k 6k 8k 10k 15k
Hz

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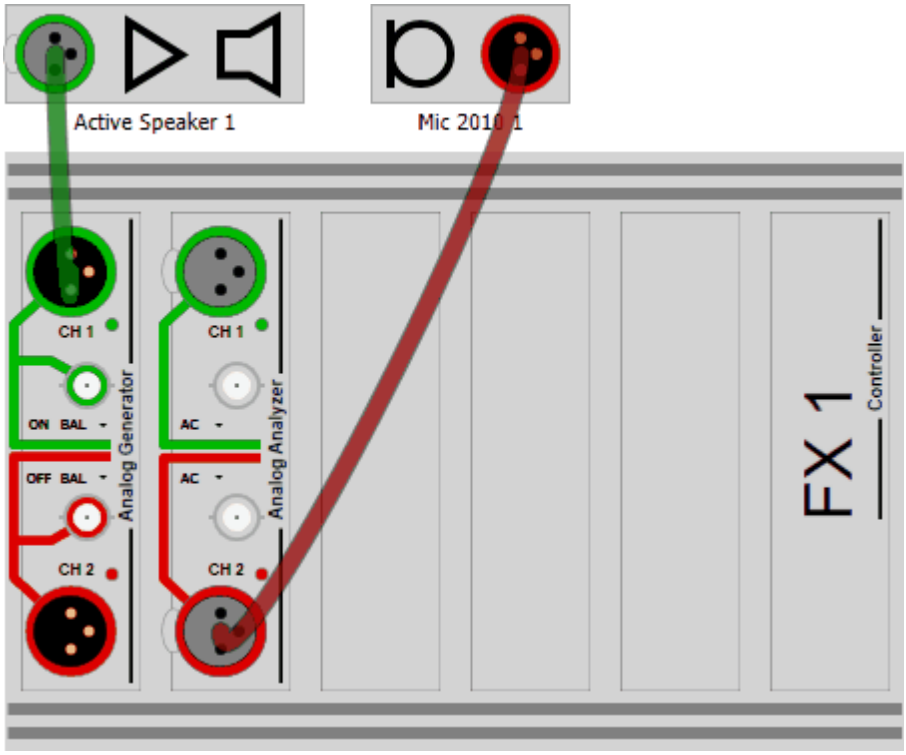
Example 4 – Custom tolerance limits for calculated Passed / Failed

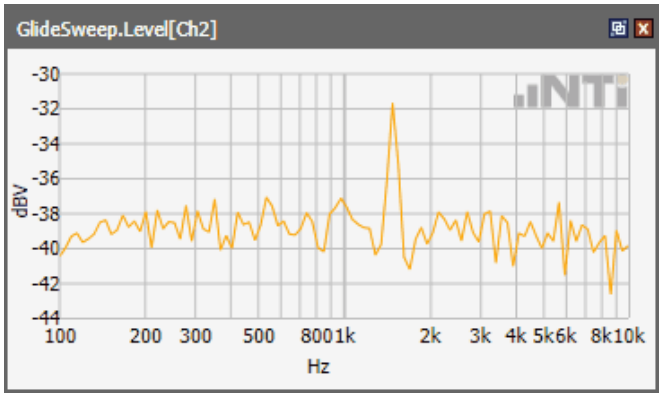
The example checks the Calculated Passed / Failed frequency response of an active loudspeaker against two custom curves that act as upper / lower tolerance limits.

Step 1 - Establish test setup and record the frequency response

a. Connect the active speaker and the measuring microphone to the FX100 instrument.



b. Measure the frequency response of a golden sample (i.e. a good working loudspeaker).



Step 2 - Customize & use the tolerance curves for calculated Passed / Failed

c. In the 'Worksheets' ribbon, click on the button 'New Calculation' and 'Custom Curve'.

d. Change the name of the custom curve to "Limit HI" and enter the X/Y values so that they represent the upper tolerance limit.

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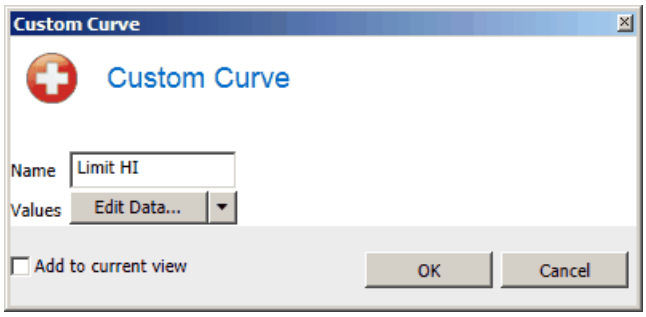
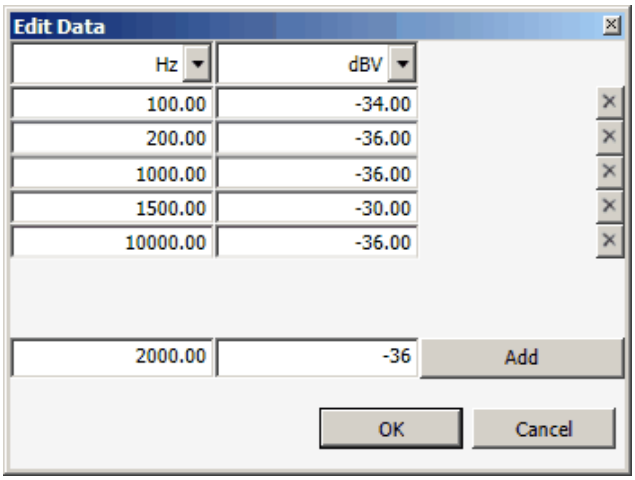
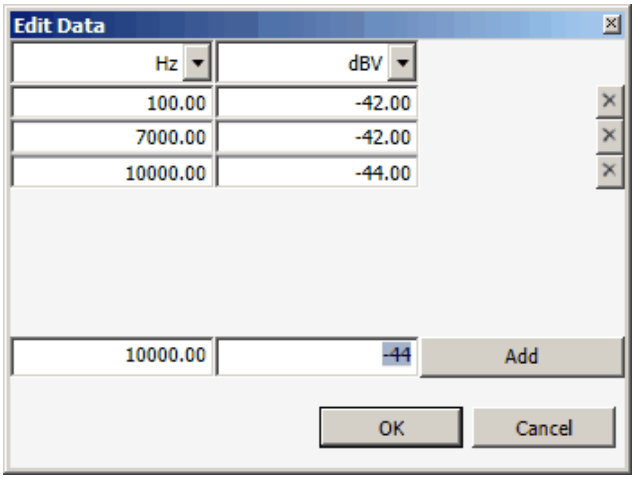


e. Edit the data, i.e. the X/Y values of the upper tolerance curve according to your demands.



f. Repeat the same procedure for the lower tolerance curve.



g. Optional: you may drag & drop the two curves (Limit HI, Limit LO) from the toolbox to the panel with the Golden Sample measurement result, in order to verify the definition of the two limit curves.

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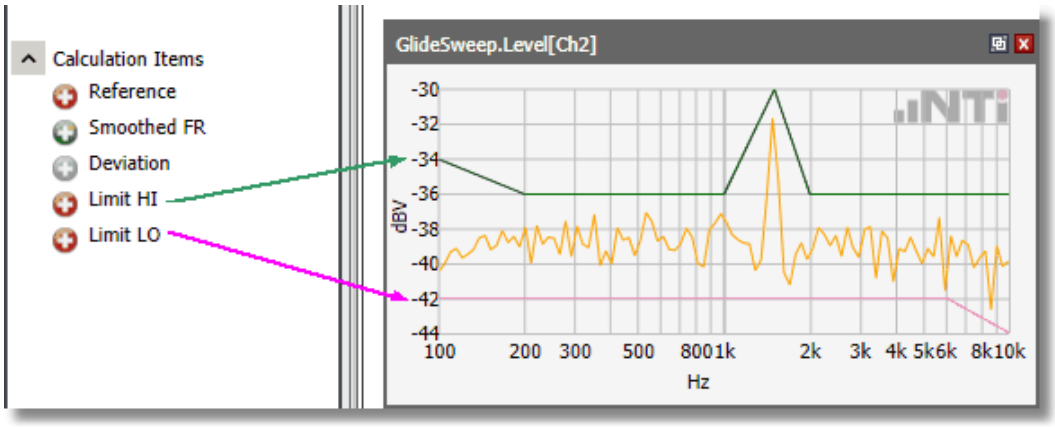
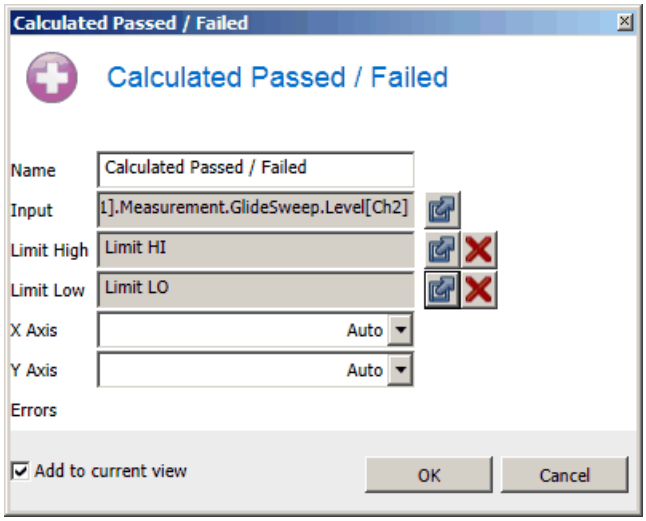
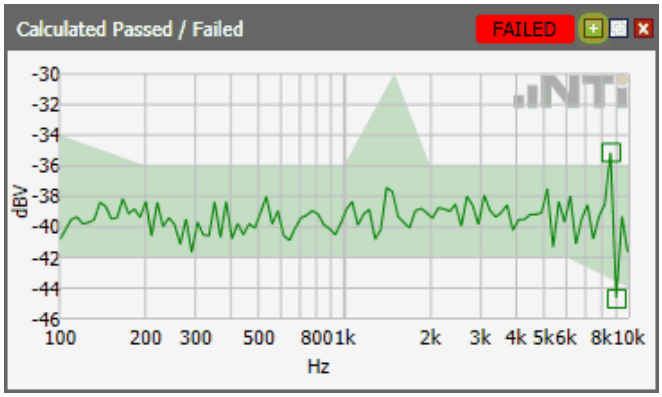


f. Add a 'Calculated Passed / Failed' item and select the measurement function as input, and the two custom curves as Limit High, Limit Low



g. Every further measurement will be consequently checked against the two limit curves, and the outcome displayed via the Calculated Passed / Failed panel.



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Part

9 Tolerance limits

A measured or calculated result can be checked against user-defined tolerance limits, thus providing a PASS/FAIL classification. Tolerance limits...

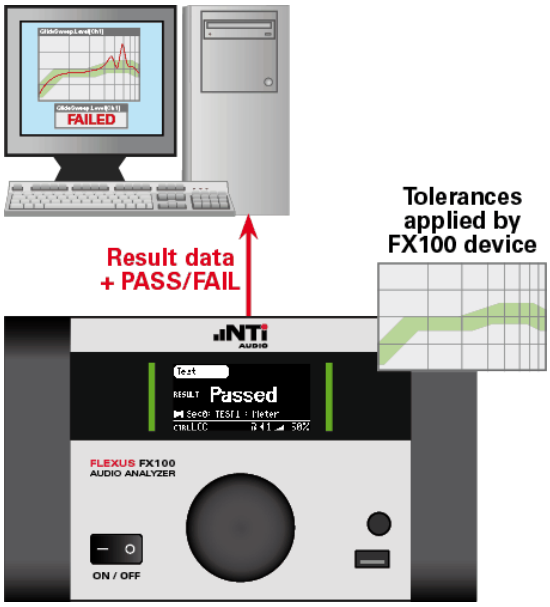
- ...can be edited & applied for Meter or StepSweep / GlideSweep measurements, or calculated results,
- ...can be defined as absolute or relative values,
- ...are adaptive to the type of measurement (e.g. distortion ⇒ only upper limits),
- ...in a sequence can only be edited if the corresponding state is active (i.e. selected),
- ...are defined independently for the analog, digital domain,
- ...are saved in the project file.

There are basically two ways to save & apply tolerance limits,

I. by the FX100 device,
II. by FX-Control software.

NOTE Software limit amendments will be shown immediately, whereas changes to a device limit become only visible after execution of the next measurement.

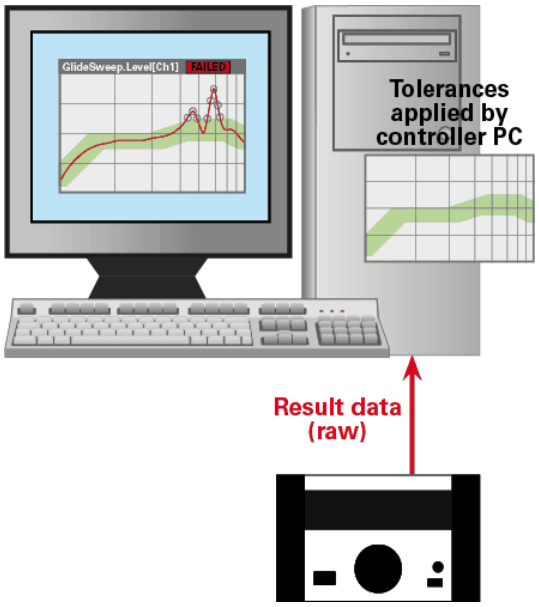
FX100 device tolerances



FX100 checks the measurement data vs. the on-board tolerance limits

- FX100 device tolerances are defined via the properties of the measurement graph; the limits are then saved & applied by the FX100 device.
- The result stream from the FX100 device to the controller PC contains the acquired measurement data and the overall PASS/FAIL information.
- Those measurement results that are beyond the tolerance limits can not be highlighted in the result graph.

FX-Control software tolerances



The controller PC checks the received measurement data vs. the tolerance limits

- FX-Control tolerance limits are defined by using calculation items; the limits are then saved & applied by the software.
- The data stream from the FX100 device to the controller PC contains only the acquired results (i.e. no PASS/FAIL classification)
- All measurement points beyond the tolerance limits are highlighted individually in the FX-Control result graph

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9.1 Device limits

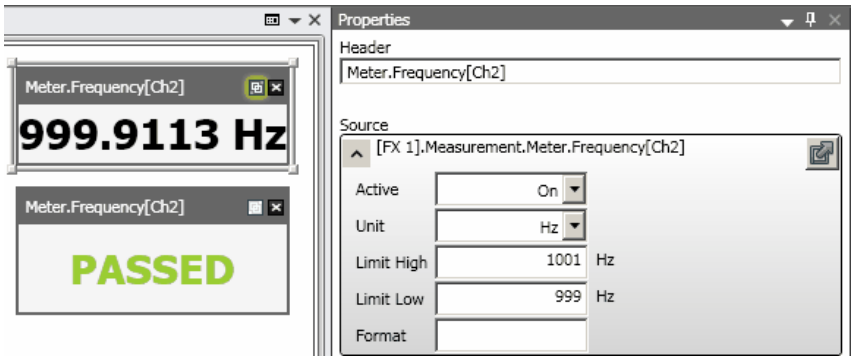
Device tolerance limits are defined via the properties of the corresponding measurement function, and then stored & applied by the FX100 device.

NOTE After amending the device limits, you have to run a measurement to apply them.

A) Absolute limits

A1) Single-value measurements

1. Place the numerical measurement display in the WorkArea and click on it.
2. In the display properties, enter the required values for the "Limit High" and "Limit Low".
3. Add a Passed/Failed display and link it to the measurement.

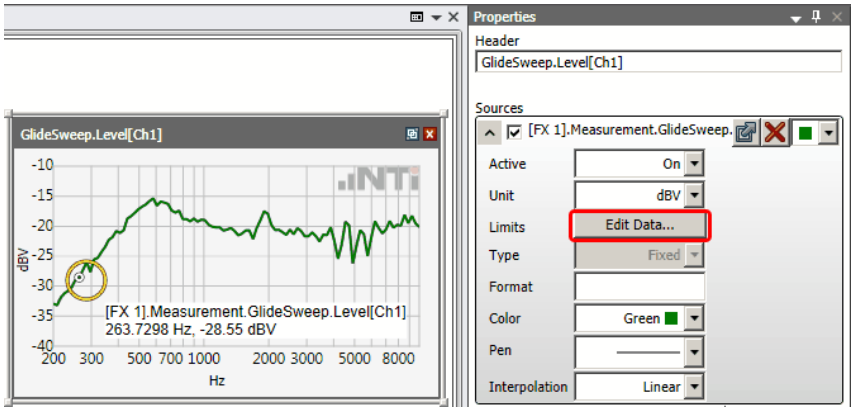


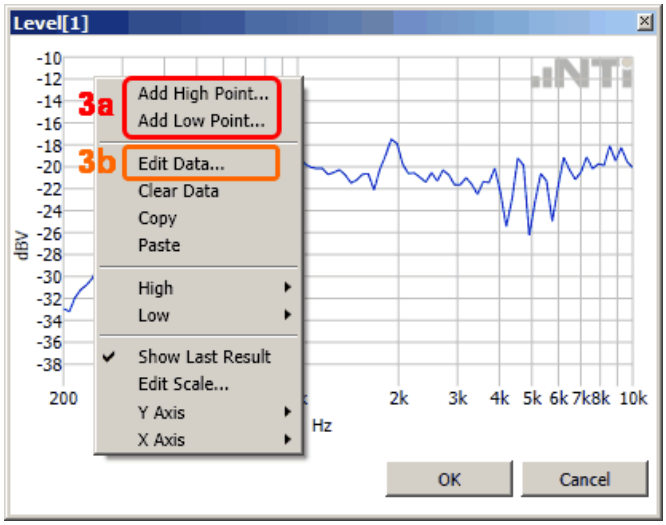
A2) Sweep, FFT measurements

1. Place the graphical measurement display in the WorkArea, execute a measurement and click on the result display.
2. In the properties of the measurement display, click on the "Edit Data..." button. Consequently, a new window opens with a graph that shows the last recorded measurement curve.
3. Define the individual upper & lower tolerance limits, either graphically or numerically (see below)

3a. *Graphical* limit definition.

   i. Right-click on the graph,
   ii. select "Add High Point..." or "Add Low point...",
   iii. click to the corresponding spot on the graph to add an upper or lower tolerance limit,
   iv. slide any point to a different position with the left mouse button if necessary, and
   v. repeat steps i.-iv. as many times as required to establish the tolerance band.





NOTE At least the first Low Point must be placed below the lowest High Point (and vice versa).

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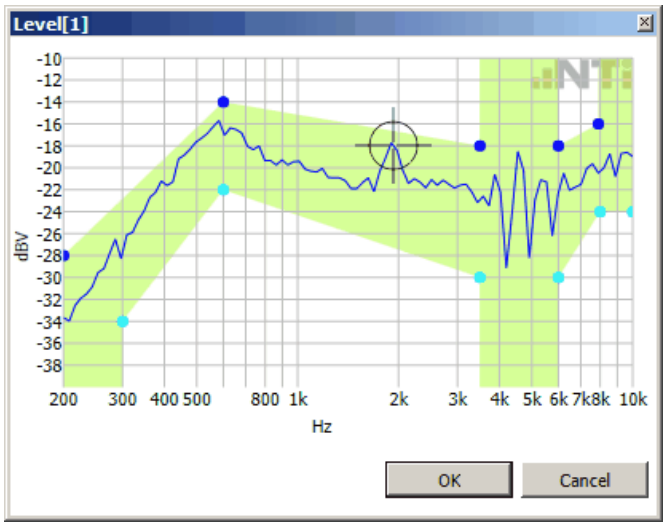
Hint ***The scaling can be amended by right-clicking on the graph and selecting 'Edit Scale...'***

With the 'Copy', 'Paste' menu entries it is possible to exchange the tolerance amongst identical measurements (e.g. level chn1 → chn2)



3b. *Numerical* limit definition.

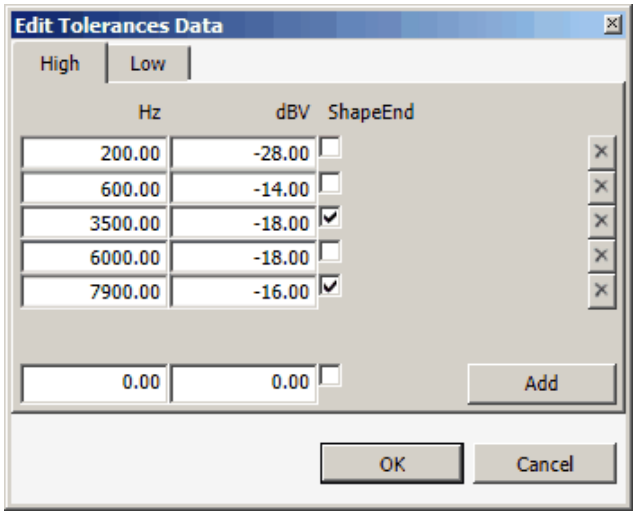
i. Right-click on the graph and select "Edit Data...".

ii. Enter the frequency / tolerance values and click on 'Add'.

iii. Tick the checkbox 'ShapeEnd' if no tolerance limits shall be applied beyond the corresponding point (i.e. measurement results beyond that point are always rated 'don't care'). If another tolerance limit is added at a higher frequency, the tolerance band continues from that point onwards. The tolerance limit with the highest frequency has always a 'ShapeEnd'.

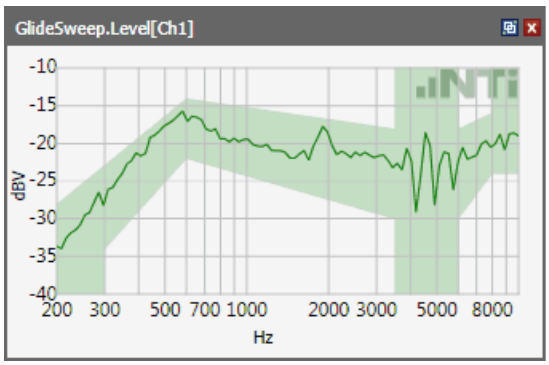
iv. Add the 'Low' tolerance limits (if applicable).

v. Click on 'OK' to terminate the definition process.



4. Execute a measurement to display the edited tolerance limit, and to verify if the recorded curve is within the limits.

5. Add a Passed / Failed display and link it to the measurement to show the outcome of the test.



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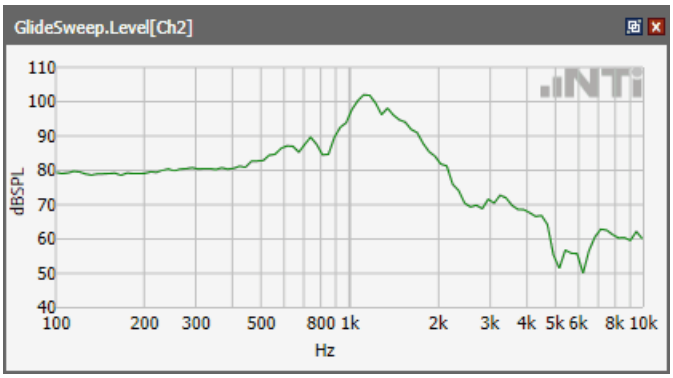
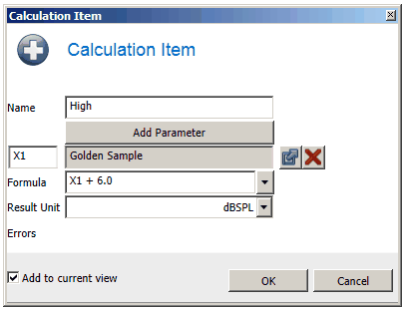
B) Relative tolerance limits

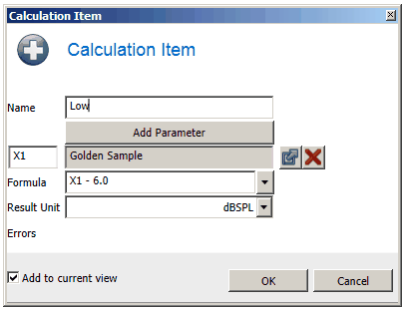
B1) Limits based on a single 'Golden Sample'

1. Place the measurement graph in the WorkArea and acquire the reference measurement(s) by using a single 'Golden sample'.
2. Keep the recorded curve and optionally rename it (e.g. "Golden Sample")

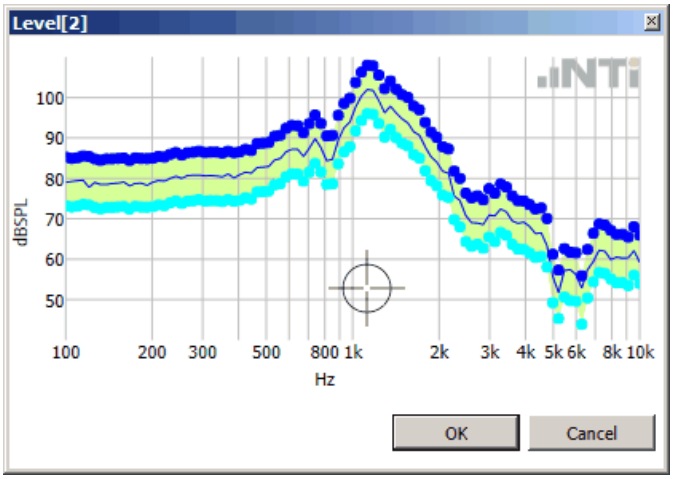


3. Create a generic calculation item via the 'Worksheets' ribbon, optionally rename it (e.g. "High" or "Low"), click on "Add Parameter" and select the kept "Golden Sample" curve.
4. Enter the Formula for the upper or the lower limit, select the correct Result Unit and click on "OK" (optionally you can show the two limit curves in the same graph via drag & drop of the "Low" item over the "High" graph in the WorkArea).





5. Right-click on the "High" or the "Low" limit curve and select 'Copy Data' from the pop-up menu.
6. In the 'Source' properties of the measurement graph, click on the 'Edit Data...' button ⇒ a graph opens that shows the last recorded curve.
7. Right-click on the graph and select
   - "High → Paste" to use the copied curve as upper limit,
   - "Low → Paste" to use the copied curve as lower limit.
8. Click on 'OK' to confirm (or abort via 'Cancel').



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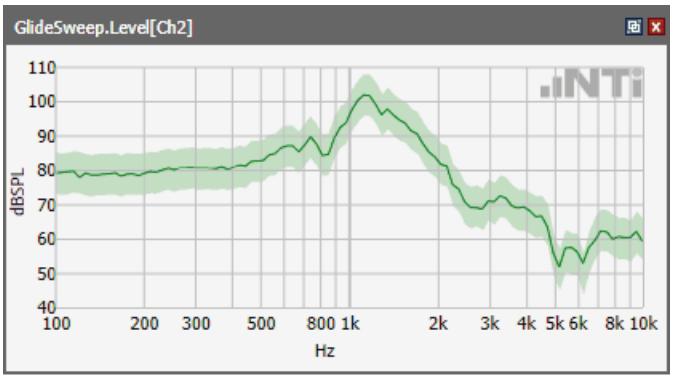
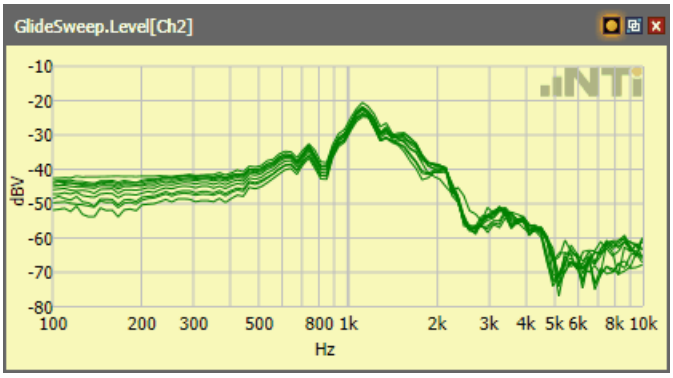
9. Add a Passed / Failed Display and link it to the measurement.
10. Run a measurement to show the device limits, the last measurement curve and the Passed / Failed result.

Hint ***Those measurement results that are beyond the device limits (i.e. failed) can not be highlighted***

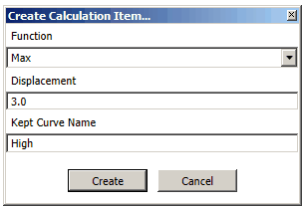


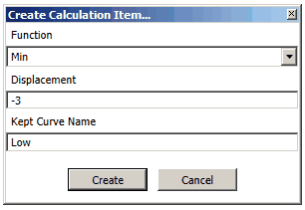
B2) Limits based on multiple references

1. Place a Line Graph Collector in the WorkArea and acquire the reference measurement(s) by using a decent number of good working samples.

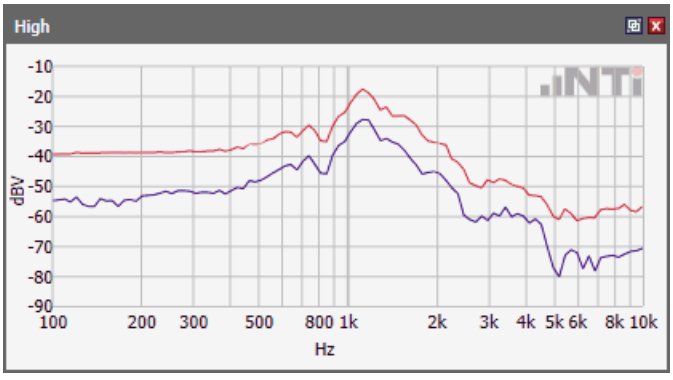


2. In the properties of the measurement graph, click on the button "Create Calculation Item...", then select Max, Min, Mean or RMS and enter the + or – tolerance headroom for the High or Low limit, respectively.
3. If required, repeat step 2. for the alternate limit.





4. Drag & drop the two calculation items "High" and "Low" to the WorkArea.
5. Right-click on the upper curve and select "Copy Data" from the pop-up menu.



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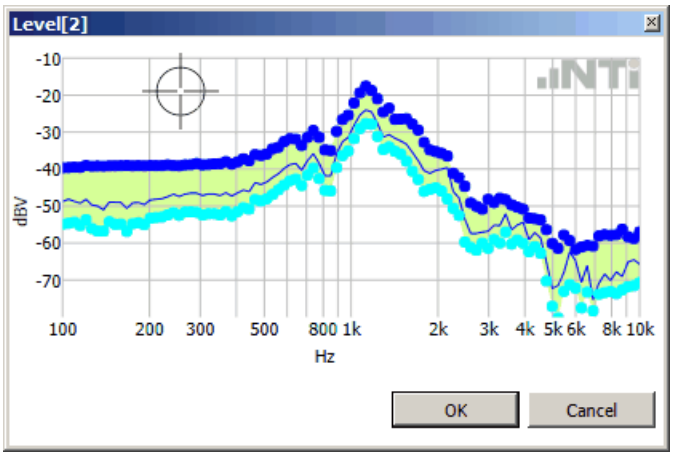
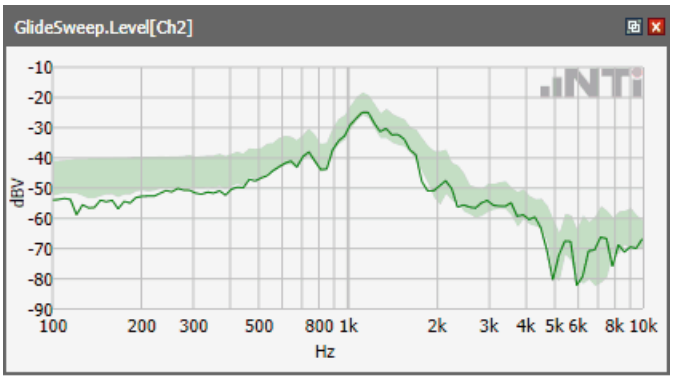
6. In the 'Source' properties of the Line Graph Collector, click on the 'Edit Data...' button ⇒ a graph opens that shows the last recorded curve.
7. Right-click on the graph and select
   - "High → Paste" to use the copied curve as upper limit,
   - "Low → Paste" to use the copied curve as lower limit.
8. Click on 'OK' to confirm (or abort via 'Cancel').



9. Place a measurement graph in the WorkArea, together with a Passed / Failed display and run the measurement(s).

Hint ***Those measurement results that are beyond the device limits (i.e. failed) can not be highlighted***



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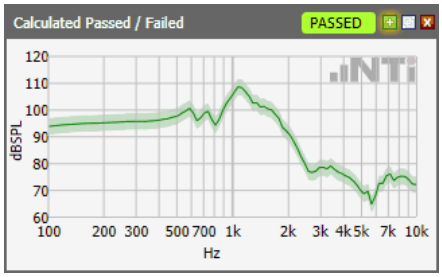
9.2 Software limits

Software tolerance limits are defined by using the 'Calculated Passed / Failed' calculation item, and then stored & applied by FX-Control.

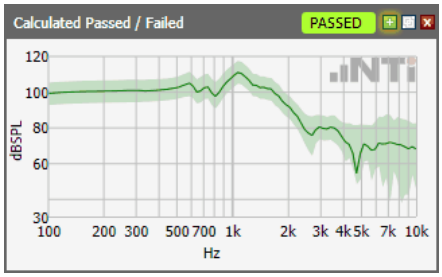
There are three ways to define software limits.

A) Based on a single measurement curve



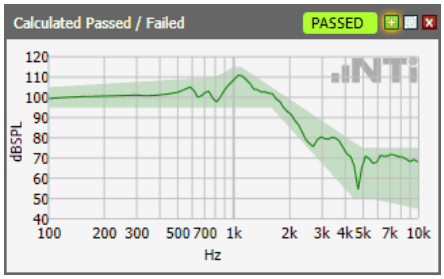
Example: Single reference curve ±3 dB

B) Based on several measured curves



Example: Min/Max of collected curves ±6 dB

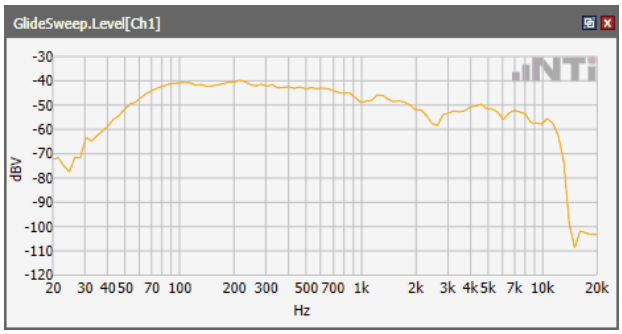
C) Based on a manually edited curve



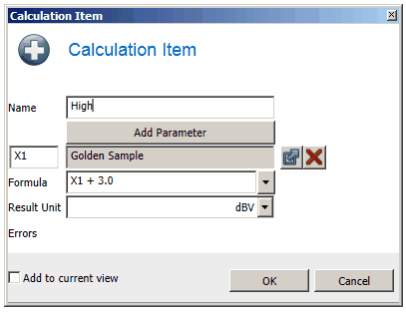
Example: Microphone limits acc. IEC 61672

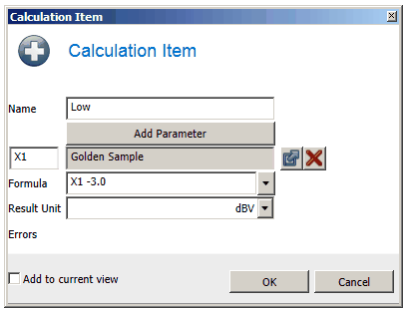
A) Software limits based on a single 'Golden Sample'

1. Adjust the generator settings and place the required measurement graph(s) in the WorkArea.
2. Connect the reference DUT to the FX100 and run the measurement(s).
3. Keep the recorded curve(s); optionally rename it/them, e.g. 'Golden Sample'.



4. Create a generic calculation item; optionally rename it (e.g. "High" or "Low").
5. Click on the 'Add Parameter' button, select the previously saved 'Golden sample' curve and define the Formula for the + or – tolerance headroom of the upper or lower tolerance limit.
6. Select the 'Result Unit' of the current measurement and click on "OK".
7. Optionally repeat steps 4. to 6. to create the opposite limit.
8. Open a 'Calculated Passed / Failed' ⇒ the 'Calculated Passed / Failed' pop-up opens.
9. Click on the button on the right hand side of the line labeled 'Input' and select the active measurement.
10. Click on the buttons on the right hand side of the lines "Limit Low / High", select the corresponding calculation items (as defined in steps 4. to 7.) and click





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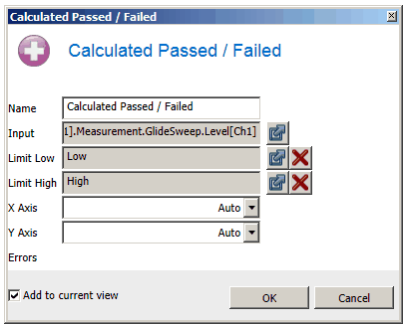
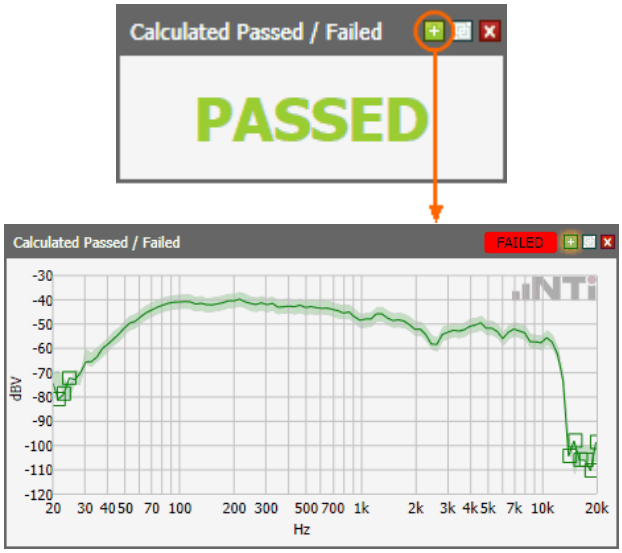


The software limits are now ready for application ⇒ as soon as you run a measurement, the acquired data will be checked against the Low, High limits and the Passed / Failed result is displayed

Click on the button ⊞ in the top bar of the Passed / Failed panel to show the

- tolerance limits (green band),
- last acquired result curve (green line),
- failed measurement points (green rectangles).



Normalized result (alternate display mode)

It is also possible to display the result curve in a normalized way, where only the deviations of the acquired measurement data from the Golden Sample are shown (i.e. flat line = perfect compliance of the measured device with the Golden Sample).

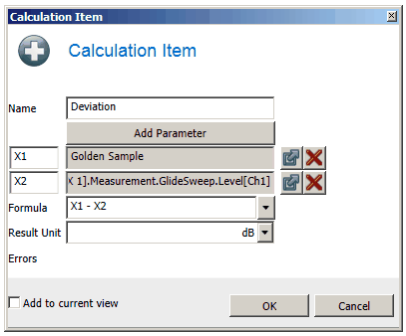
i. Execute steps 1. to 7. as above.

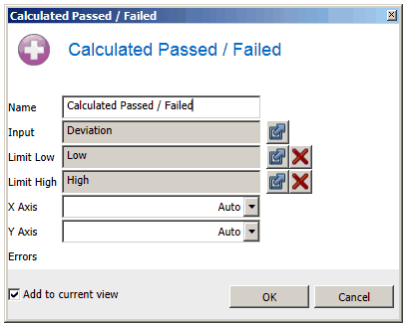
ii. Create a generic calculation item (e.g. labeled "Deviation").

iii. Select the Golden Sample and the current measurement as inputs and enter the Formula that subtracts these two inputs from each other.

iv. Select the Result Unit "dB" and click on "OK".

v. Repeat steps 8. to 10., but select the "Deviation" item as Input





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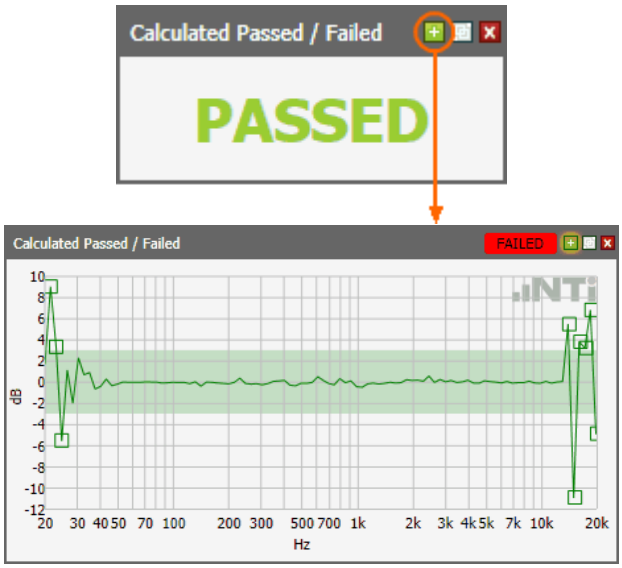
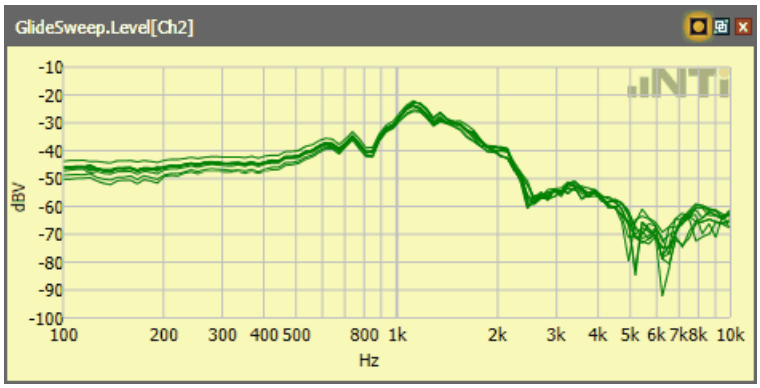
vi. Click on the ⊞ button in the top bar of the Passed / Failed panel to show the normalized result graph with the tolerance band and the failed measurement points.

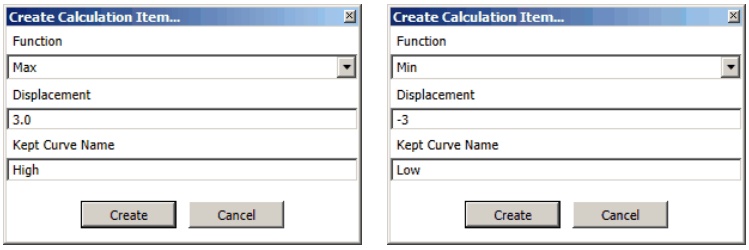


B) Software limits based on multiple reference samples

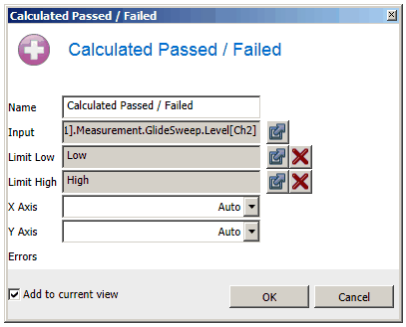
1. Adjust the generator settings and place a Line Graph Collector of the required measurement function in the WorkArea.



2. In the properties of the Line Graph Collector, click on the button "Create Calculation Item...", then select Max, Min, Mean or RMS and enter the + or – tolerance headroom for the High or Low limit, respectively.
3. If required, repeat step 2. for an alternate limit.



4. Click on the button 'Calculated Passed / Failed' in the 'Worksheets' ribbon, select the measurement function and assign the Low, High limits (i.e. the corresponding items from steps 2., 3.).



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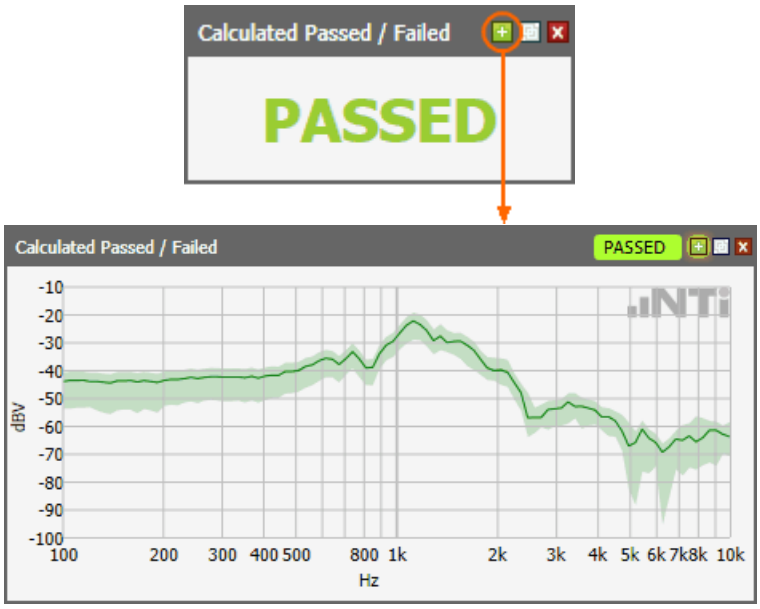
Optionally click on the button in the top bar of the Passed / Failed panel to show

- tolerance limits (green band),
- last acquired result curve (green line),
- failed measurement points (green rectangles).



Semi-automated tolerance update procedure (option)

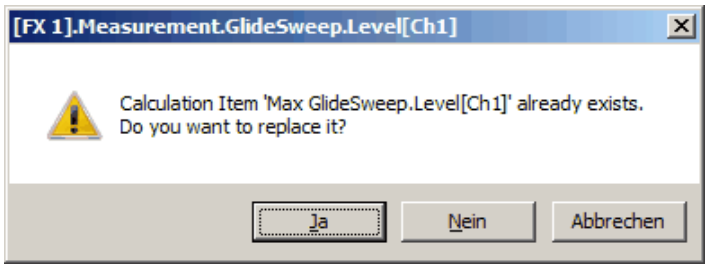
a. Execute steps 1. to 4. as described above.

b. Record more curves in the Line Graph Collector

c. In the properties of the Line Graph Collector, click again on the button "Create Calculation Item...", select the required Function (e.g. Max) and optionally amend the Displacement.

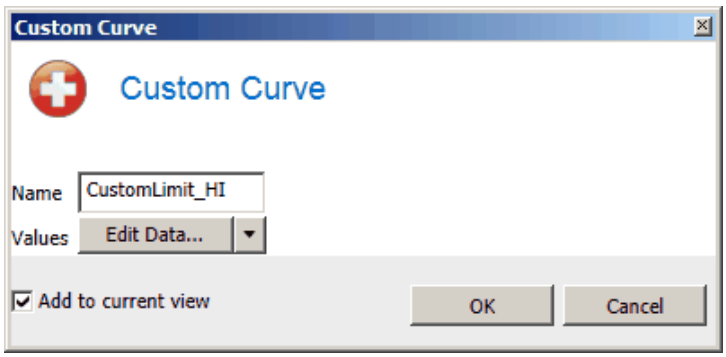
d. As soon as you confirm via the "Create" button, a pop-up will appear that asks you, whether the existing Calculation Item shall be overwritten? → Click on OK to confirm.

Consequently, the old tolerance limits will be replaced by new ones that are based on the larger number of recorded curves and the amended offset.



C) Manually edited (generic) software limits

1. In the 'Worksheets' ribbon, click on the Custom Curve button (under "New Calculation")
2. Amend the name of the custom curve
3. Click on "Edit Data..."



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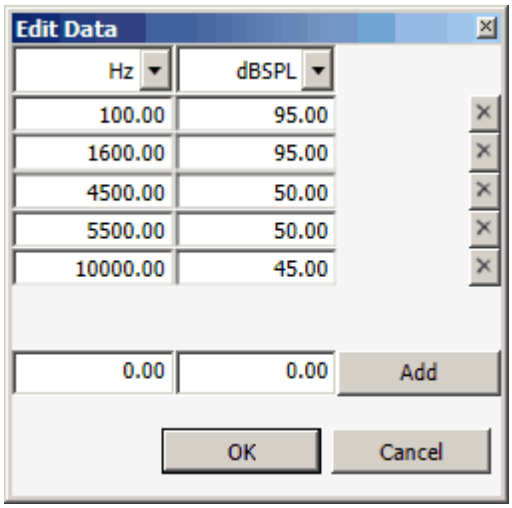
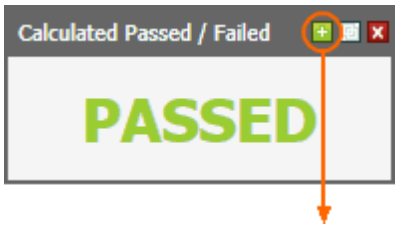
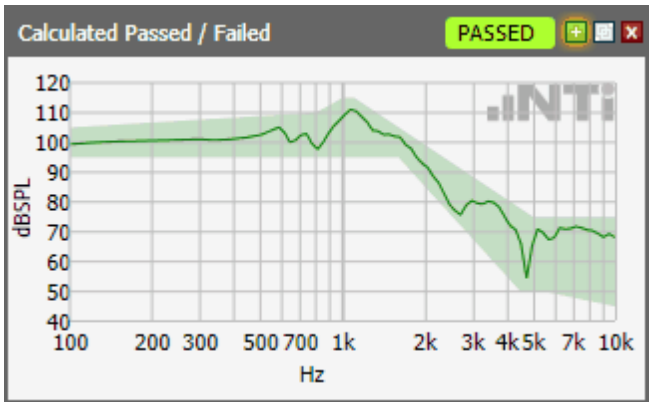
4. Select the appropriate unit(s).
5. Define the requested curve by editing the corresponding points
   - Add points by entering the X-, Y-axis value in the bottom line and clicking on the "Add" button (gaps between neighbored points will be interpolated linearly).
   - Amend the values of existing points directly.
   - Delete obsolete lines from the table by clicking on the button.
6. Confirm by clicking on "OK".
7. Optionally repeat steps 1. - 6. to define the opposite limit (lower ↔ upper).
8. Click on the button 'Calculated Passed / Failed' in the 'Worksheets' ribbon, select the measurement function and assign the Low, High limits (i.e. the corresponding items from steps 1. - 7.).
9. Optionally click on the button in the top bar of the Passed / Failed panel to show
   - tolerance limits (green band),
   - last acquired result curve (green line),
   - failed measurement points (green rectangles).







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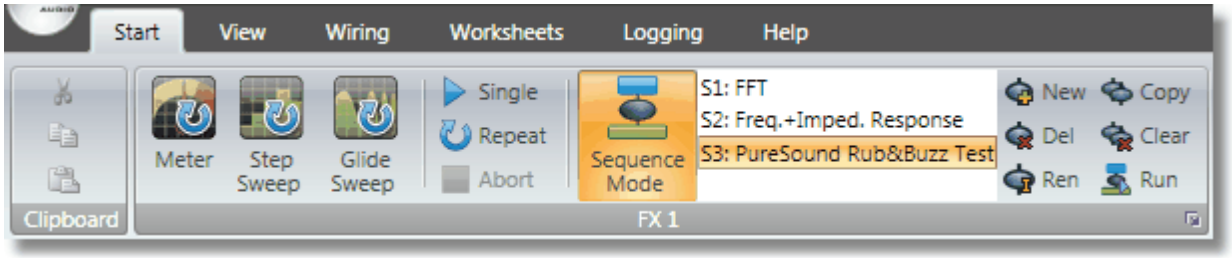
Part

10 Sequences

The sequence feature is accessible via the 'Start' ribbon.



A sequence can be described as the *automated execution of consecutive states and steps*, which have been edited by the operator, e.g.

- customized measurements (Meter, StepSweep or GlideSweep)
- interactions with the user (e.g. prompt, input request)
- program calls (e.g. run executable)
- delays
- activate a specific sheet (i.e. bring it to the front view)
- data outputs (processing of manually entered or measured values)
- build reports (exports selected data to a document)

The states, steps can be arranged arbitrarily within a sequence and are executed in the defined order, whereby

- the wiring applies globally on all states of the sequence
- the routing (e.g. active I/O channels) can be defined individually for every state
- the generator, analyzer settings (e.g. output level, active filters) and measurement functions are activated individually for every state, whereby the panels stay permanently visible in the WorkArea
- the calculation items are global, though the corresponding inputs may be taken from an individual state
- the regulators are global; their outcome may be applied to all states, *or* on a single state only.

A) Set up procedure

A1) Establish the sequence

Hint ***Before you define a new sequence, it is strongly recommended to clear all panels from the WorkArea or to open a new project.***

1. Enter the sequence mode by clicking on the button 'Sequence Mode' in the Start ribbon
2. Define the wiring
3. Create the required states (*see below*)
4. Click on 'Run' to execute the complete sequence
5. Save the sequence and all related states in a project

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A2) Edit & arrange the states, steps

1. Create a new state by clicking on 'New'.
2. Adjust the contents of the new state (or edit an existing state) as follows
   - Select the state by clicking on 'State *x*'
   - Define the routing (e.g. active channels of the generator, analyzer or SIL, SIH boards or input/output switchers)
   - Adjust the generator, analyzer settings
   - Activate the measurements and define the tolerance limits
   - Define the calculation items (optional)
   - Introduce the regulators (optional)
3. If required, delete a selected state by clicking on 'Del'.
4. Save the project to secure the definitions or changes.

Hints ***Only the settings of the active (i.e. selected) state can be edited.***

The states must be established in the same order as they shall be executed in the sequence.

If a new state is added, all settings & items of the previous state are duplicated ⇒ Use the clipboard to paste the corresponding items on a new worksheet.

Only one sequence can be defined & saved per project.

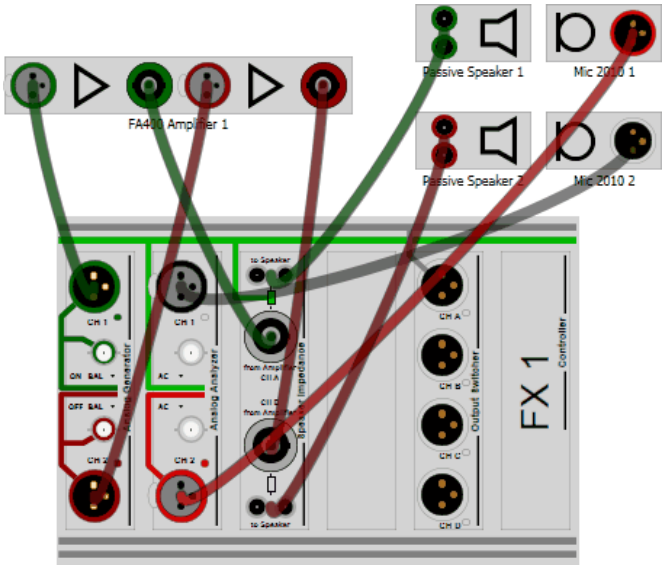
B) Behavior of wiring, panels, regulators, calculation items

B1) Wiring, routing

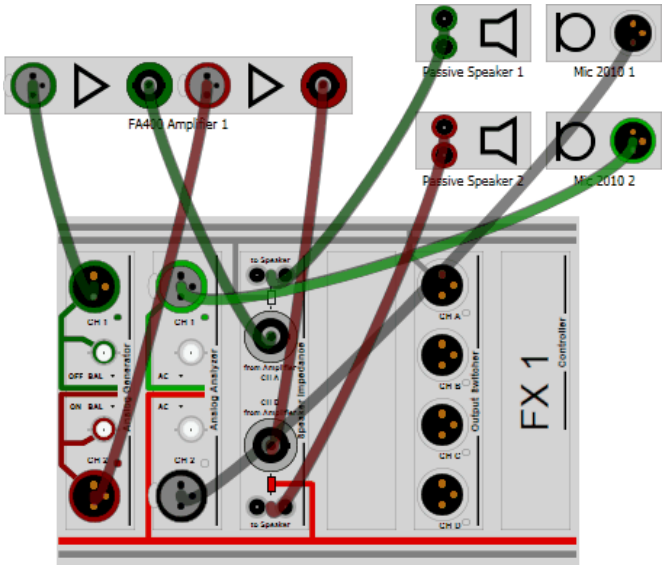
General rules

- Within a sequence, the wiring is global, i.e. it applies for all states of the sequence.
- On the other side, the routing of the involved channels is individual for every state, i.e. can be changed within the sequence.

Example



State 1: Wiring = global / Routing = state-dependent



State 2: Wiring = global / Routing = state-dependent

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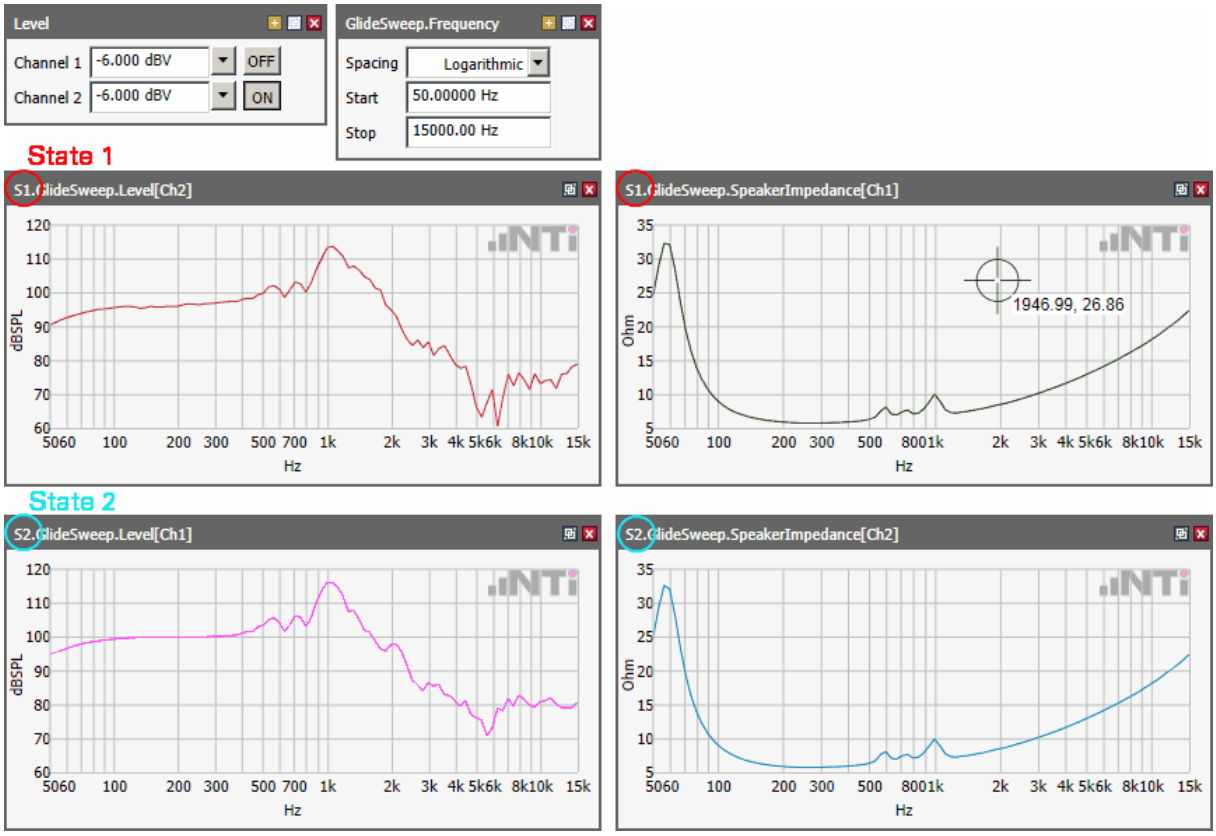
B2) Panels

General rules

- All panels (e.g. generator settings, result displays) that are placed in the WorkArea remain visible throughout all states.
- If a panel is added to the WorkArea just after the sequence mode has been entered, i.e. before any state has been added, it remains active for all states.
- If a panel is added in a specific state, it applies only for that state, whereby the panel's name is preceded by "Sx" (x = state-#).

Example



Global generator settings and individual measurement results of state 1, state 2

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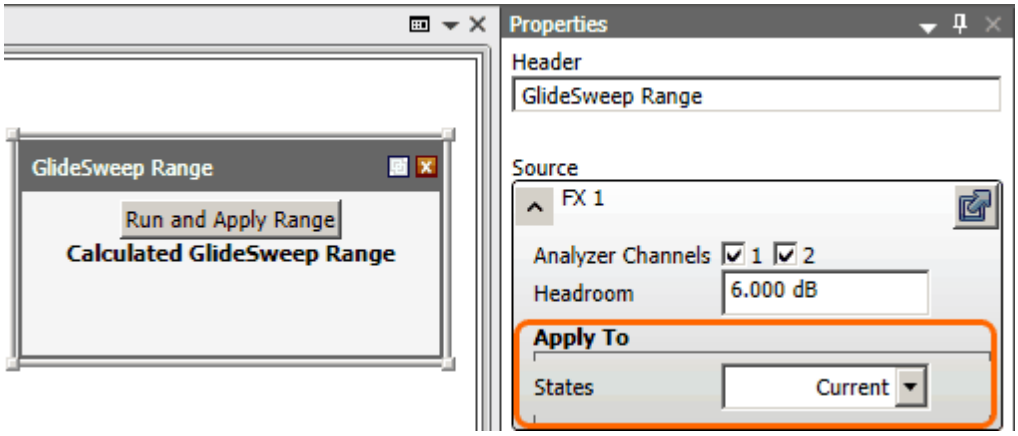
B3) Regulators

General rules

- Regulators can not be initiated by a sequence, i.e.they have to be controlled manually.
- The outcome of a Regulator procedure however can be applied to all states or to the current state only (via the properties of the regulator).

Example



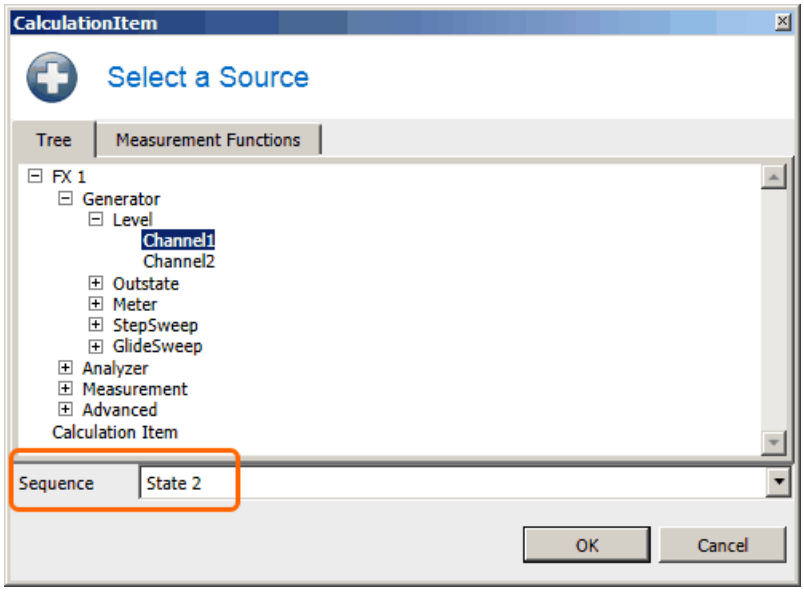
Regulator is applied on the current state only

B4) Calculation items

General rules

- Calculation items are global, i.e. they are always active.
- The input parameter(s) for a calculation item however may be taken from a specific state.

Example



Calculation item uses the Generator Level Channel1 as defined in state #2

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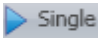
C) Sequence execution

C1) Manual controls

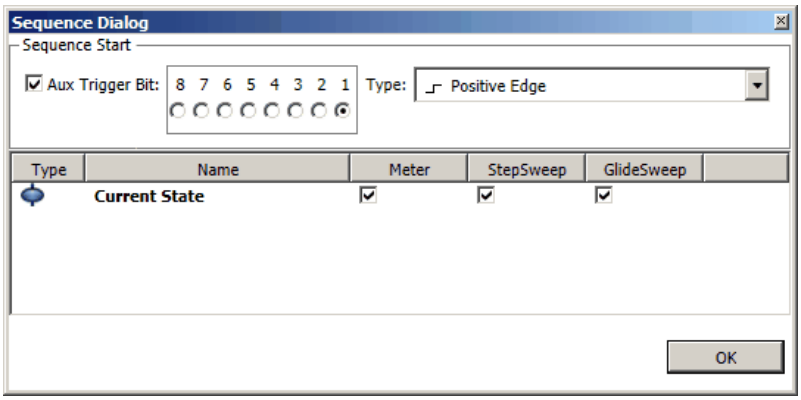
or **F5** or	Starts the sequence (single shot)
or **F6**	Starts the sequence in repeat mode
	Executes the selected state only
	Executes the selected state in repeat mode
or **F8**	Stops the sequence execution

C2) Auxiliary trigger

A sequence can be initiated by an externally generated trigger signal (e.g. from a PLC or foot switch etc.) that is connected to the auxiliary I/O interface.

1. Tick the checkbox 'Aux Trigger Bit' to enable the external trigger.
2. Select the trigger condition, i.e. the auxiliary input bit (1...8) and the slope type (positive / negative edge).
3. Click on 'OK' to confirm the setting.

Hint ***If only the Auxiliary Trigger is enabled, i.e. without adding further states or steps to define a sequence, the software will only execute the active measurement(s) as soon as the trigger signal arrives.***



Auxiliary trigger setup

Hint ***As soon as the sequence execution is started, the previously acquired active measurement or calculation results are cleared.***

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10.1 Establish a sequence

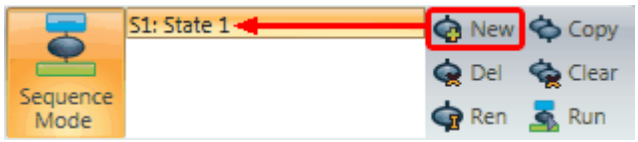
Step 1

Establish the basic wiring (i.e. all firm devices & connections)

Step 2

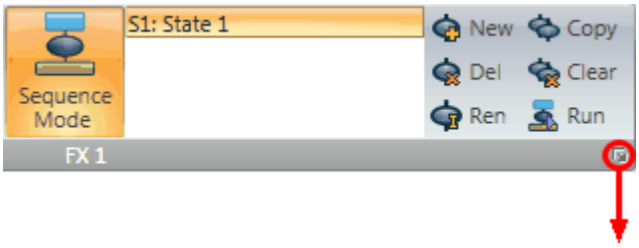
i. Enter the sequence mode by clicking on the button 'Sequence Mode' in the Start ribbon and click on New.

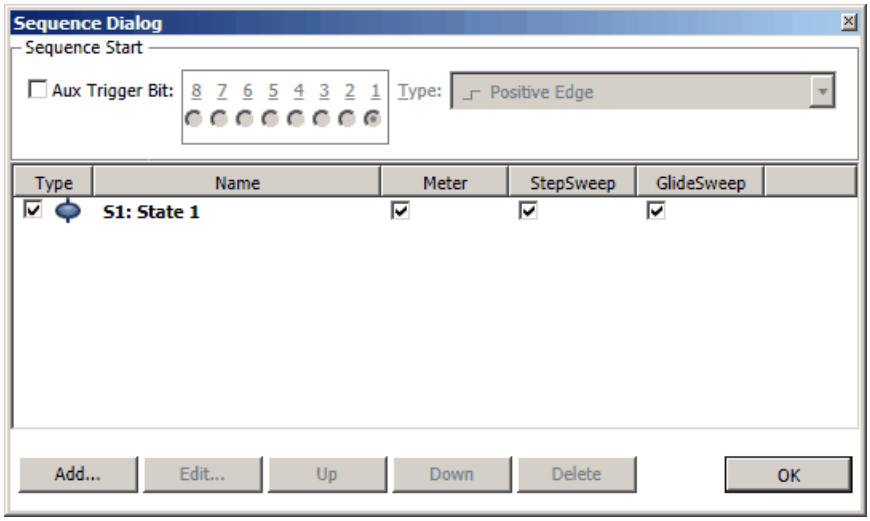
Hint ***Before you define a new sequence, it is strongly recommended to clear all panels from the worksheet or to open a new project.***



ii. Amend the internal FX100 routing (e.g. output/input switcher routing) or connector states (e.g. mute On/Off, bias) if required.

iii. Click on the dialog box launcher, select the measuring modes that shall be active (Meter, StepSweep or GlideSweep) and click on 'OK'





iv. Customize the state, i.e.

a) adjust the generator, analyzer settings and the active measurements according to your demands,

b) add and edit special actions via the 'Sequencer Dialog' window if required,

c) rename a state by clicking on Ren or on 'Edit' in the 'Sequencer Dialog' window.

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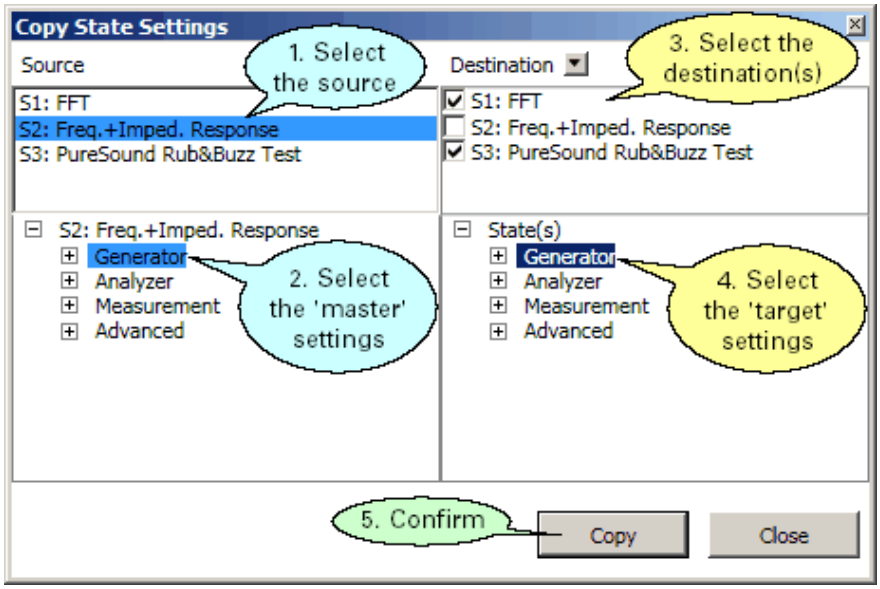
Step 3

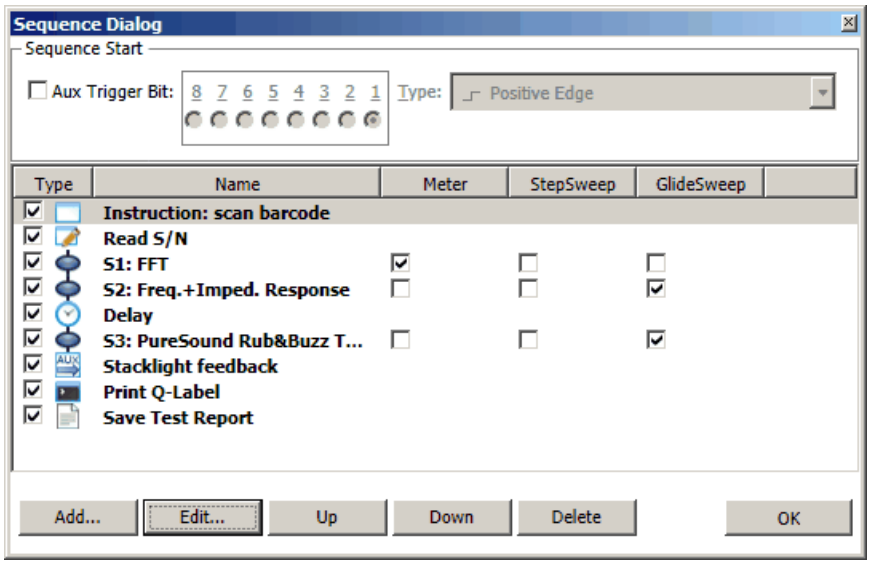
i. Add more states by clicking on New

ii. If you want to copy the settings of a specific state to some or to all other states, click on Copy and select the source / destination state(s) and the applicable settings.



iii. Remove an obsolete state by clicking on Del or clear the whole sequence via Clear

iv. Customize each state individually (as described under *Step 2*, ii.-v.)



Step 4

i. Start the sequence by clicking on Run or pressing the <F5> key.

ii. Keep an eye on the trace in order to get notice of error messages.

iii. Save the setup with the sequence in a project.

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10.2 States, steps

Definition

- A *state* is a customized collection of FX100 instrument settings, test parameters and measurements.
- A *step* is a predefined action.

States (instrument settings)

When you add a new state to a sequence, you must adjust the following settings.

A) Measurement operating mode(s)

Minimum one measurement operating mode must be active

- Meter
- StepSweep
- GlideSweep

Hint ***If a state comprises 2 or 3 measuring modes, they are executed in the order Meter → StepSweep → GlideSweep***

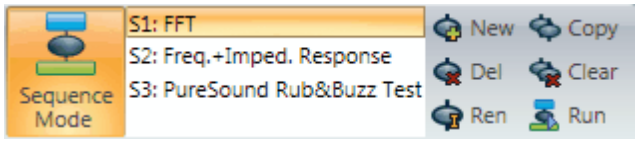
B) Test parameters

- generator settings
- analyzer settings

C) Measurements

Minimum one measurement function must be active.

Hint ***The name of every state begins with an identifier (e.g. S1, S2, ...), followed by as description (e.g.) . The identifiers are invariant, whereas the descriptions can be edited by clicking on*** Ren ***or via the 'Sequence Dialog' window.***



Example of edited state descriptions

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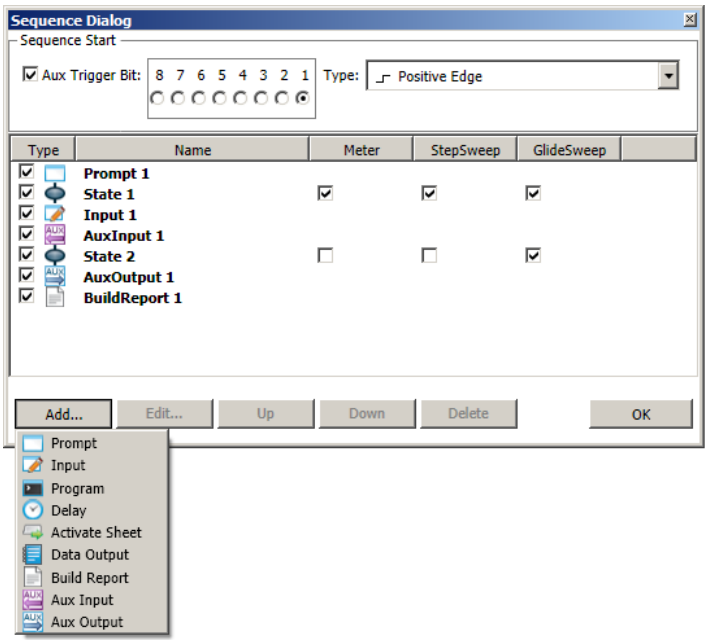
Steps (predefined actions)

To add a step, click on the 'Add' button in the 'Sequencer Dialog' window. Consequently a menu appears with the available actions,

- Prompt
- Input
- Program
- Delay
- Activate Sheet
- Data Output
- Build Report
- Aux Input
- Aux Output



After having added a step to the sequence, it can be

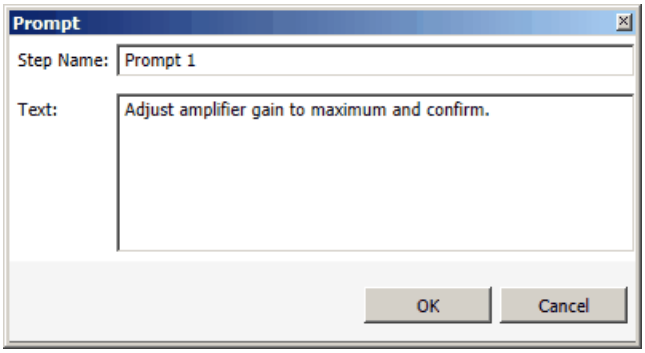
- edited
- disabled / enabled
- deleted
- moved within the sequence with the 'Up', 'Down' buttons.

Hint ***Keep in mind that a sequence may be triggered (started) manually or via the auxiliary I/O interface.***

Prompt

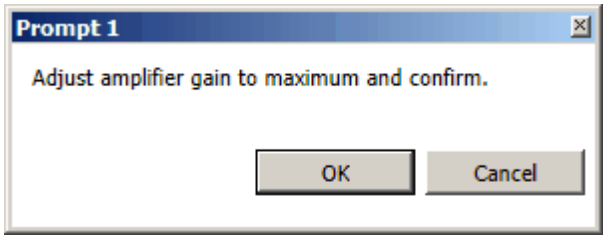
Halts the sequence, and opens a dialog box with customized text, that has to be confirmed by the operator. For instance, this feature allows to advise the customer to perform a manual action before the sequence can be continued.

1. Select the menu 'Prompt', optionally edit the Step Name and enter the instruction text that shall be displayed to the operator.
2. Click on 'OK' to confirm your definitions.



Prompt execution during a sequence

- Operator takes no action → sequence remains halted.
- Operator clicks on the 'OK' button → sequence execution continues.
- Operator clicks on 'Cancel' → sequence is stopped (aborted).



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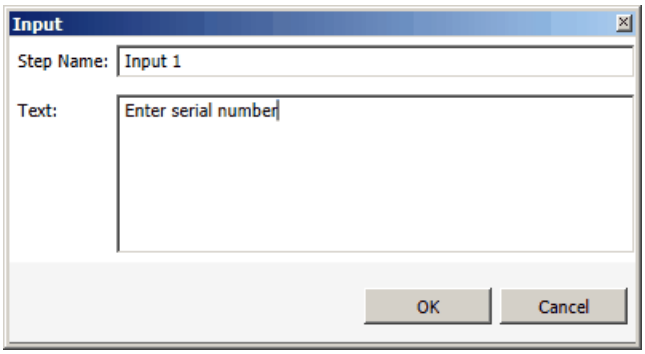
Input

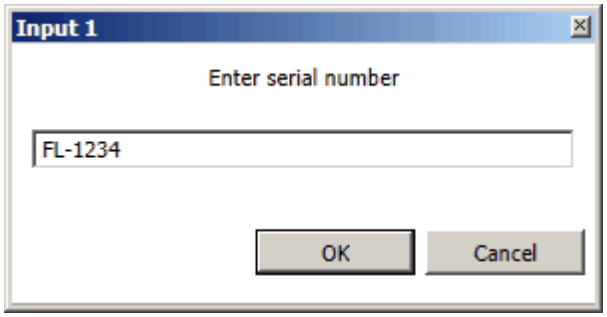
Halts the sequence and asks the operator to enter a string. This string then becomes available in the 'Data Output' window or can be used for the 'Program' or 'Build Report'.



1. Select the menu 'Input', optionally edit the Step Name and enter the instruction text that shall be displayed to the operator.
2. Click on 'OK' to confirm your definitions.

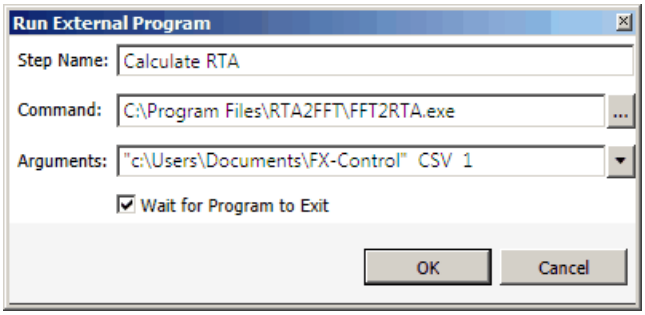
Input execution during a sequence

- Operator takes no action → sequence remains halted.
- Operator enters string and clicks on 'OK' → the software internally stores the entered string and continues executing the sequence.
- Operator clicks on 'Cancel' → sequence is stopped (aborted).



Program

Runs an external program, which is identified by a Command. The Command may include argument(s). The sequence may be halted during the program execution. Furthermore, the sequence can be aborted (canceled) if the command exit code is not zero (0).



1. Select the menu 'Program' and optionally re-name the Step Name.
2. Enter the command line, i.e.
   - manually enter or paste the required command line string, or
   - click on the ... button and select the executable vi the explorer.
3. Optionally enter the argument(s), i.e.
   - manually enter or paste the required string, or
   - click on the ▼ button and select one of the listed arguments.
4. Optionally tick the checkbox 'Wait for Program to Exit' if the sequence shall be halted until the execution of the external program is finished.
5. Click on 'OK' to confirm your definitions.

Program execution during a sequence

- The external program is called as soon as the sequence has reached the corresponding point.
- If the checkbox has been ticked, the sequence halts until the external program is finished

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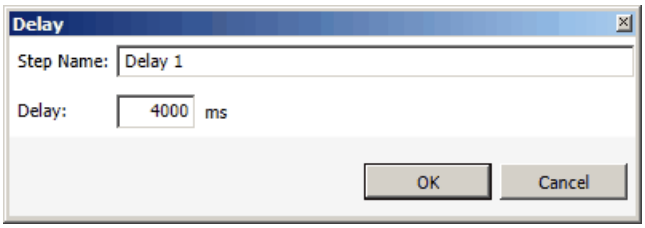
Delay

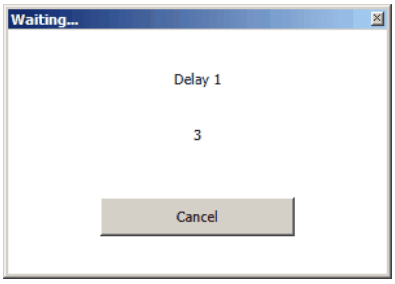
Halts the sequence during a user-defined time.

1. Select the menu 'Delay' and optionally edit the Step Name.
2. Enter the duration of the delay.
3. Click on 'OK' to confirm your definition.



Delay execution during a sequence

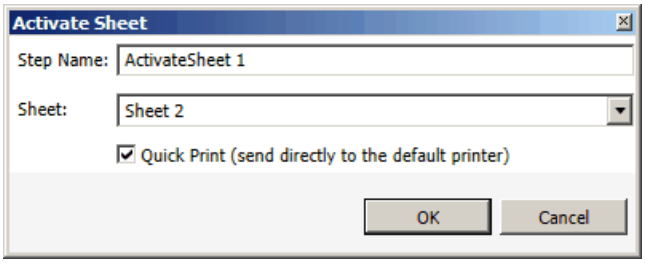
- As soon as the sequence comes to the corresponding point, it halts for the defined duration.
- If the operator clicks on 'Cancel' → sequence is stopped (aborted)



Activate Sheet

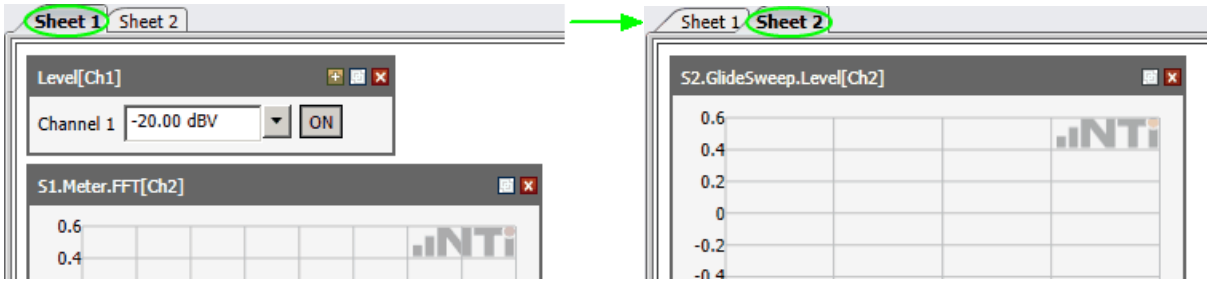
Brings the selected worksheet to the front.

1. Select the menu 'Activate Sheet', optionally edit the Step Name.
2. Click on the button and select the required worksheet.
3. Click on 'OK' to confirm your selection.



Activate Sheet execution during a sequence

As soon as the sequence is at the corresponding point, the selected worksheet is automatically shown in the front view.



Data Output

Exports selected data to a user-defined target file in *.csv format.

1. Select the menu 'Data Output' and optionally edit the Step Name.
2. Optionally edit the path and the name of the target file.
3. Click on 'Add' to select the data that shall be written to the target file. Consequently, the 'Edit Parameter' window opens, wherein you have to
   - enter a string for the Header (i.e. label of the saved contents),
   - click on the button and select the Content(s) that shall be saved in the target file.

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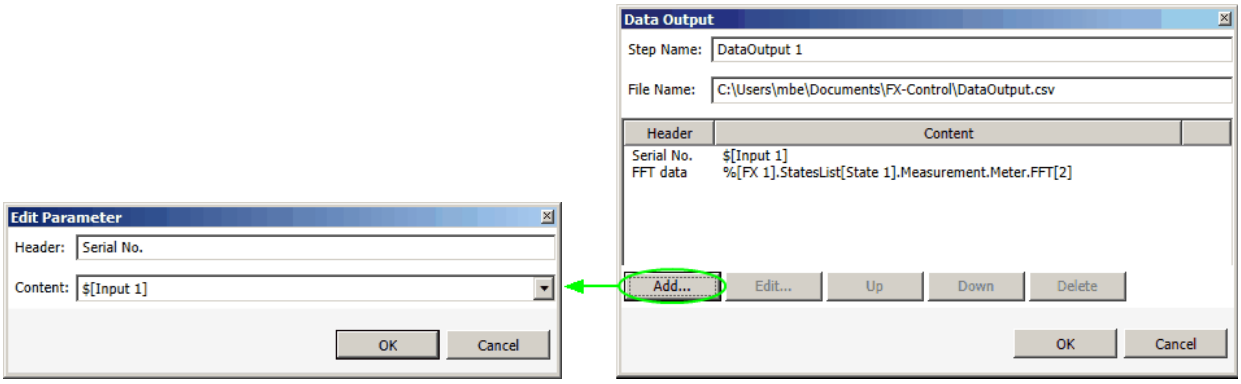
4. Click on 'OK' to confirm your definitions.



Data Output during a sequence

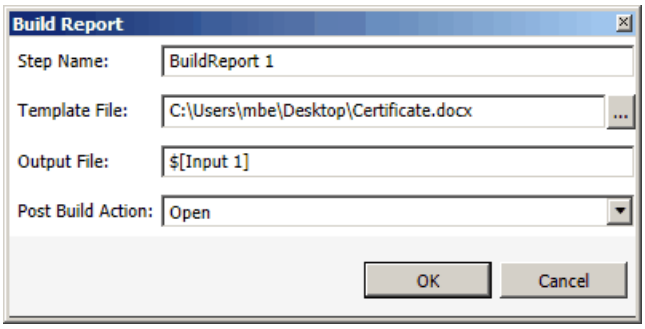
As soon as the sequence is at the corresponding point, the software writes the selected data (i.e. header and measured results) to the target file.

	A	B	C	D	E	F	G	H
1	Serial No.	FFT data	Hz	5	5.0956225	5.1930737	5.2923884	5.3936028
2	123		dBV	-31.611679	-31.611679	-31.611679	-31.611679	-31.611679
3	124		dBV	-31.398476	-31.398476	-31.398476	-31.398476	-31.398476
4	125		dBV	-34.099255	-34.099255	-34.099255	-34.099255	-34.099255

Build Report

Exports selected data to a document (e.g. MS Word template) that has been defined by the user before.

1. Select the menu 'Build Report' and optionally edit the Step Name.
2. Click on the ... button and select the Template File, to which the data shall be exported.



3. Assign a name to the Output File (*Side note – the Output File is a copy of the Template File, to which e.g. the test results are written*). There are three alternatives to assign the name of the Output File,
   i. No name (i.e. input box is left blank) ⇒ every time the sequence is executed, a new Output File is created with the default name "<Step name><Date><Time>"
   ii. Fixed name (e.g. "Result Sheet") ⇒ every time the sequence is executed, the one & only Output File gets overwritten (*Side note – requires the Post Build Action "Print"*)
   iii. Indexed name (e.g. "$[Input x]") ⇒ every time the sequence is executed, an Output File is created with the indexed name (*Side note – if the indexed name does not change, the Output File gets overwritten*)
4. Select the action to be executed as soon as the contents have been exported.
5. Open the Template File and enter the contents that shall be exported, e.g.
   - the string that has been entered by the operator via the Input dialog → "$[Input x]",
   - the ***numerical results*** of a Meter measurement → copy the string under "Header" from the properties of the measurement function and paste it to "Output File".
6. Click on 'OK' to confirm your selection

Hint ***Using the Build Report requires advanced understanding of the program, in which the template has been established; please refer to chapter Template for build report.***

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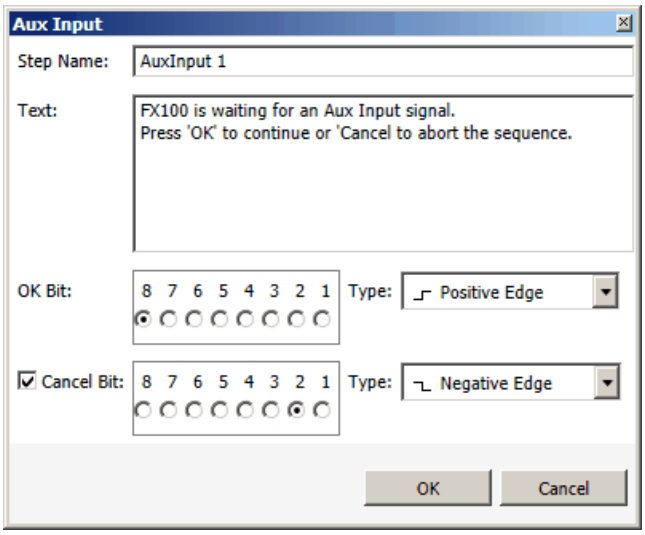
Aux Input

The sequence execution automatically halts at every 'Aux Input' step and waits until the corresponding 'OK Bit' is set via the auxiliary I/O interface.

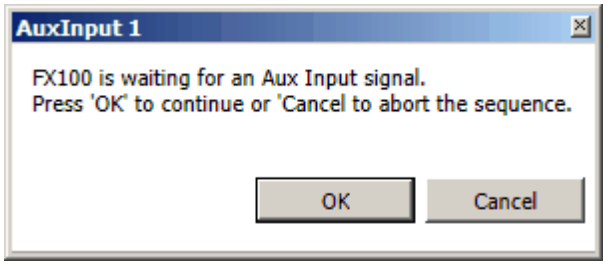


1. Optionally edit the 'Step Name' or 'Text', i.e. the title or message of the 'Aux Input' dialog box.
2. Select the 'OK Bit' (input pin 1...8), and the 'Type' (positive or negative edge) of the input signal.
3. Optionally tick the checkbox 'Cancel Bit' and select an input pin and 'Type' to allow aborting the sequence via the auxiliary I/O interface.

Hint ***If the 'Cancel Bit' is assigned to the same pin as the 'OK Bit', it is overruled by the latter.***

4. Click on 'OK' to confirm.

Hint ***As soon as the sequence execution halts, the 'Aux Input' dialog box pops up, as long as the FX100 is waiting for the Aux Input.***
The operator may then optionally force the sequence to continue (i.e. FX100 does no longer wait for the Aux Input) by pressing the 'OK' button, or cancel (i.e. abort) the sequence execution by pressing the 'Cancel' button.



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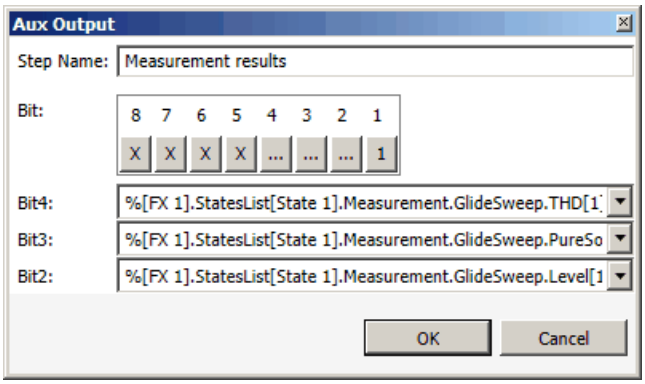
Aux Output

The software sets the status of the FX100 auxiliary I/O interface pins as defined by the user.

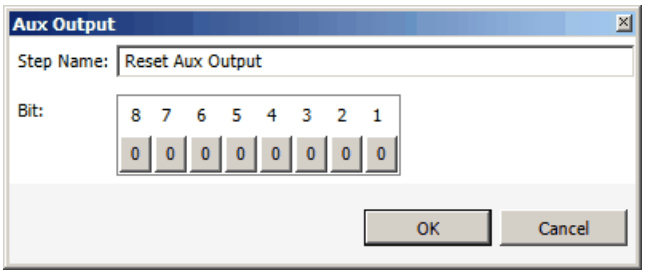

Aux Output
Step Name: Measurement results
Bit: 8 7 6 5 4 3 2 1
X X X X 1
Bit4: %[FX 1].StatesList[State 1].Measurement.GlideSweep.THD[1
Bit3: %[FX 1].StatesList[State 1].Measurement.GlideSweep.PureSo
Bit2: %[FX 1].StatesList[State 1].Measurement.GlideSweep.Level[1
OK
Cancel

1. Optionally edit the 'Step Name'.
2. Click a button below the numbers 1...8 and define the status of the corresponding bit.
   - 'X' → don't care (no change)
   - '0' → Output pin = LO
   - '1' → Output pin = HI
   - '...' + select an active measurement or a Pass/Fail calculation item from the list→ Output pin = Boolean result (Passed ⇒ 1 / Failed ⇒ 0)

Hint ***Only active measurements with a defined tolerance limit create a valid Boolean result; otherwise, they are ignored.***

3. Click on 'OK' to confirm.

Hint ***To reset the auxiliary I/O output, you must add a separate 'Aux Output' step that sets the output pins to the required values ('0' or '1').***



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10.3 Examples

The chapter provides practical examples and hints to setting up a test sequence

a) Basic amplifier test

b) Sequential analysis of 4 pcs. identical DUTs.

c) Stepwise verification of a 3-way loudspeaker cabinet.

d) Consecutive measurement of the DC resistance and AC-impedance of a DUT.

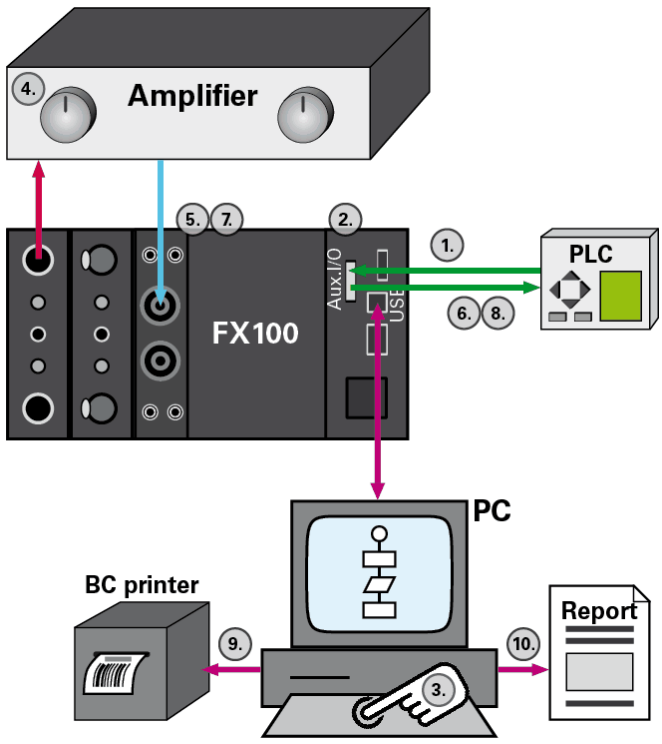
e) Octave and 1/3rd Octave band measurement (RTA)

10.3.1 a) Amplifier test

The example illustrates a basic amplifier test sequence that is controlled by a PLC.

1. PLC triggers the test sequence
2. Sequence resets the FX100 auxiliary I/O output pins
3. Operator enters the serial number of the DUT
4. Sequence prompts the operator to adjust the amplifier volume control
5. FX100 executes the Meter measurements of state #1
6. Sequence feeds the Pass/Fail feedback of state #1 to the PLC
7. FX100 executes the GlideSweep measurements of state #2
8. Sequence feeds the Pass/Fail feedback of state #2 to the PLC
9. Sequence calls an executable that prints out a barcode label (*incl. S/N from step 3.*)
10. Sequence builds a report document with the DUT's serial number, measurement data, Pass/Fail result etc.

The sketch shows the involved devices and connections, and refers to the listed sequence states & steps.



Schematic test setup and sequence flow

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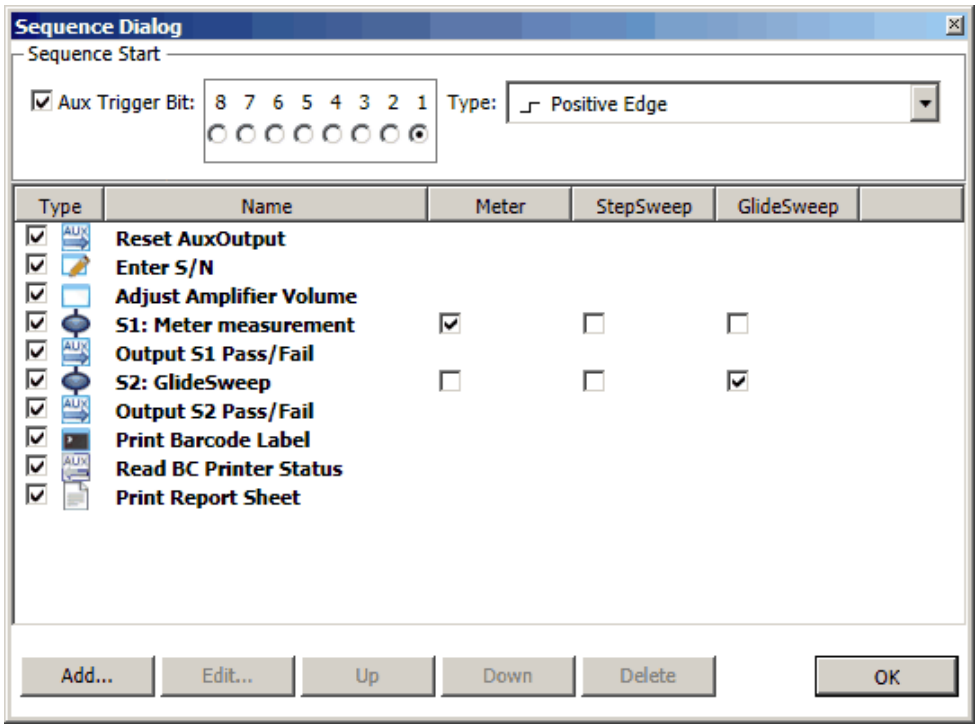
The Sequence Dialog panel shows the user-defined order of the states & steps.



Sequence dialog box

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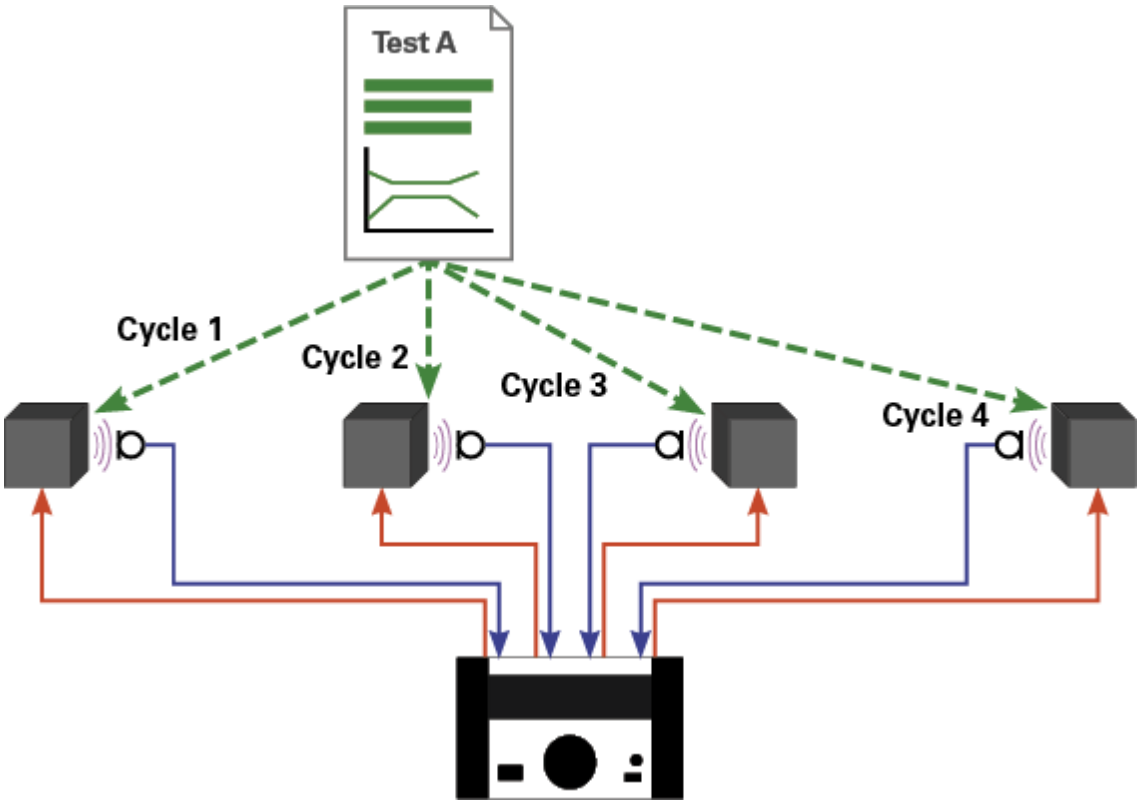
10.3.2 b) 4 identical DUTs

Test four DUTs (Devices Under Test) with the same test parameters in a row, and verify their individual frequency response.

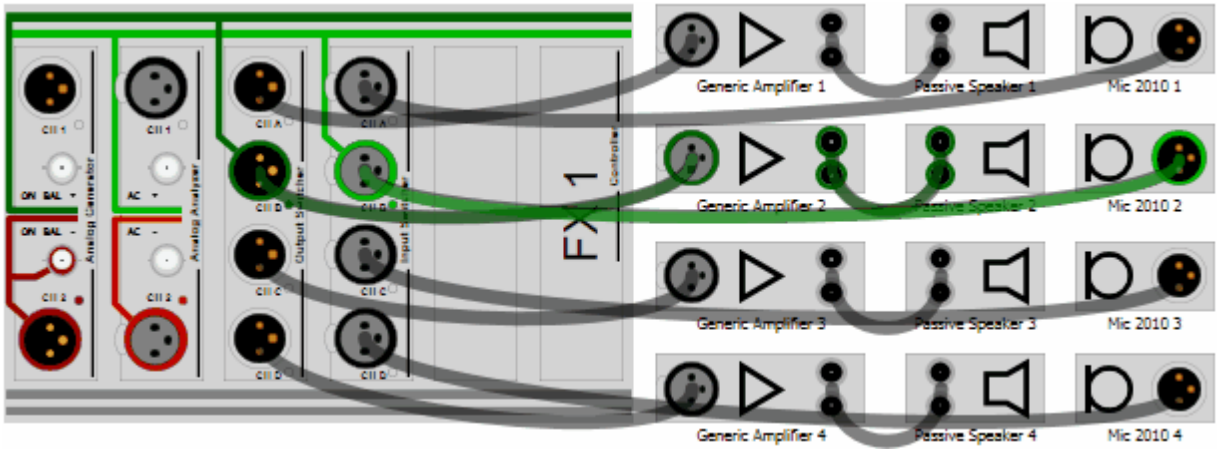
⇒ The sequence comprises four states, whereby

- the test parameters (e.g. bandwidth, test signal level) are not amended, but
- each state activates another channel of the output & input switcher.



Schematic view of switched 4-DUT test

Wiring



Wiring and internal links of State2

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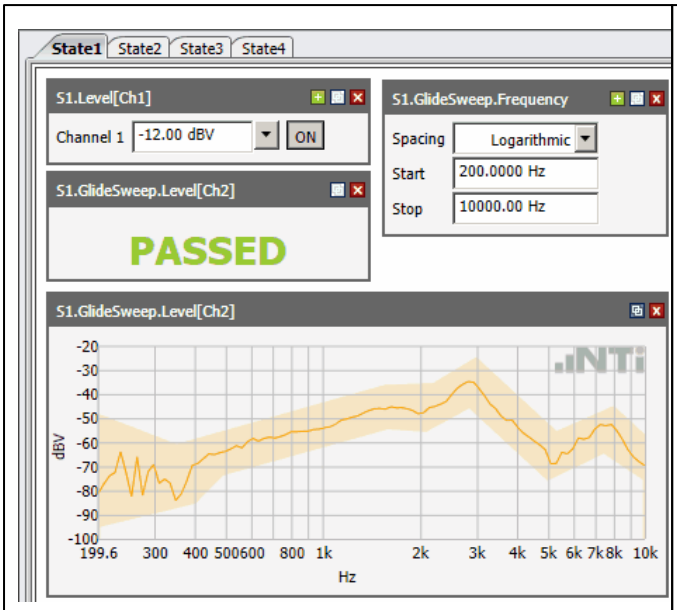
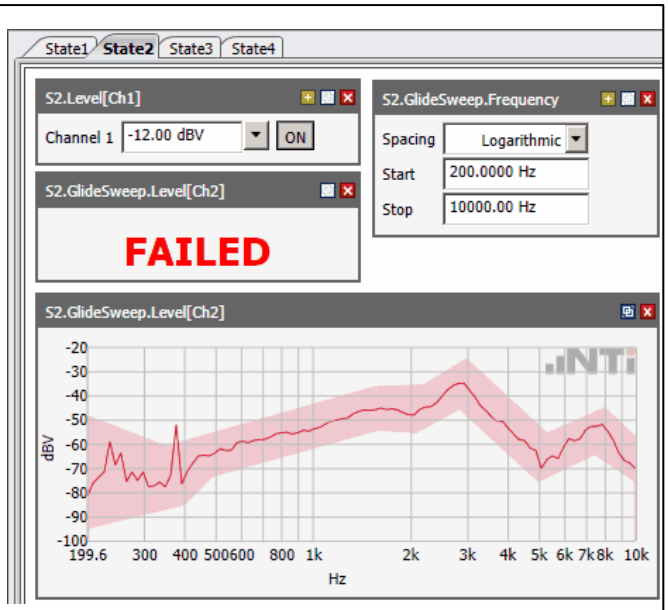
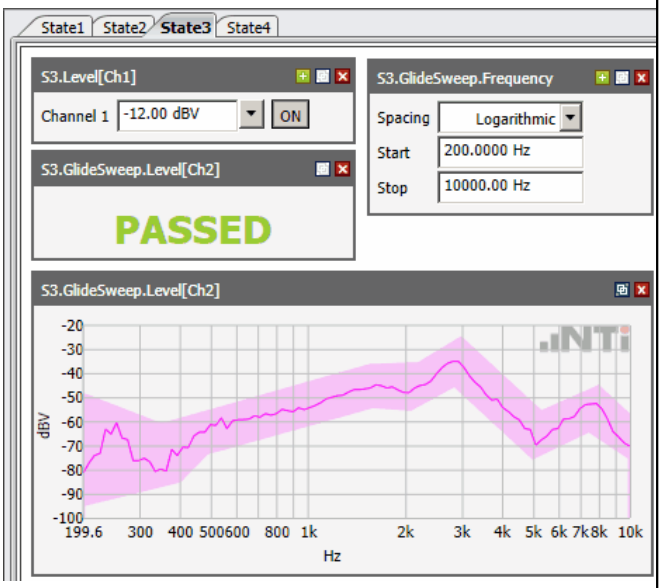
States



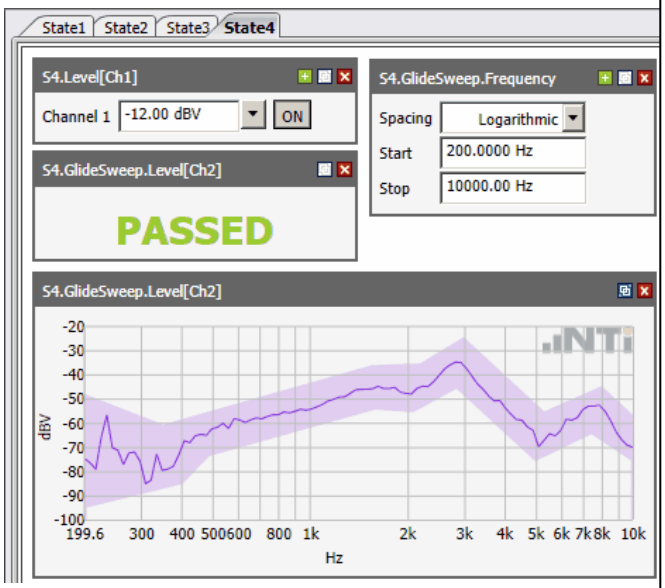
State1 test parameters & results



State2 test parameters & results



State3 test parameters & results



State4 test parameters & results

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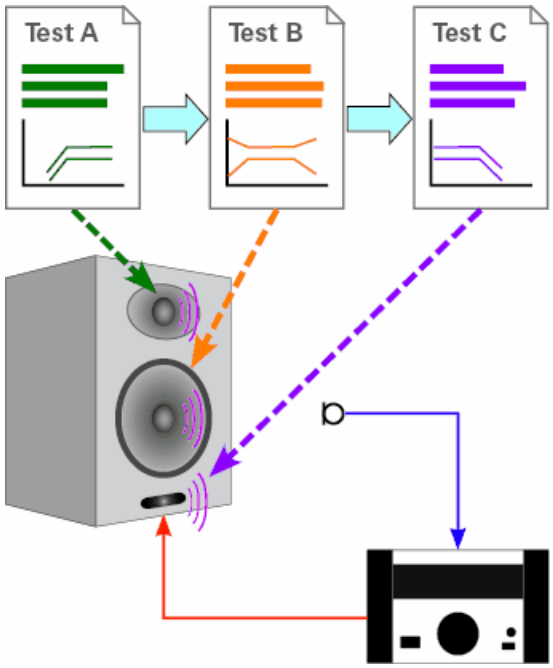
10.3.3 c) 3-way loudspeaker

Verify the frequency response & PureSound steepness of a three-way active loudspeaker, i.e. woofer, midrange driver and tweeter.

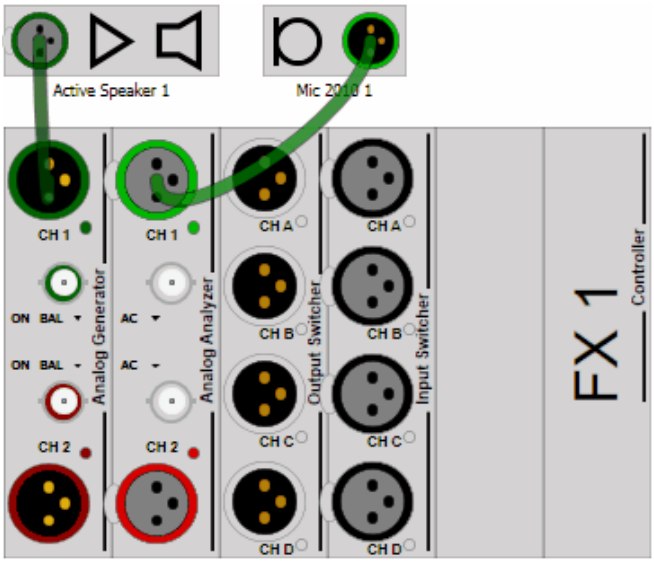
⇒ The sequence comprises three states, whereby

- each state has its individual test parameters (e.g. bandwidth, test signal level, tolerance limits etc.),
- all measurements are acquired by a single microphone.



Schematic view of switched 3-way loudspeaker test

Wiring



Wiring for active 3way loudspeaker test

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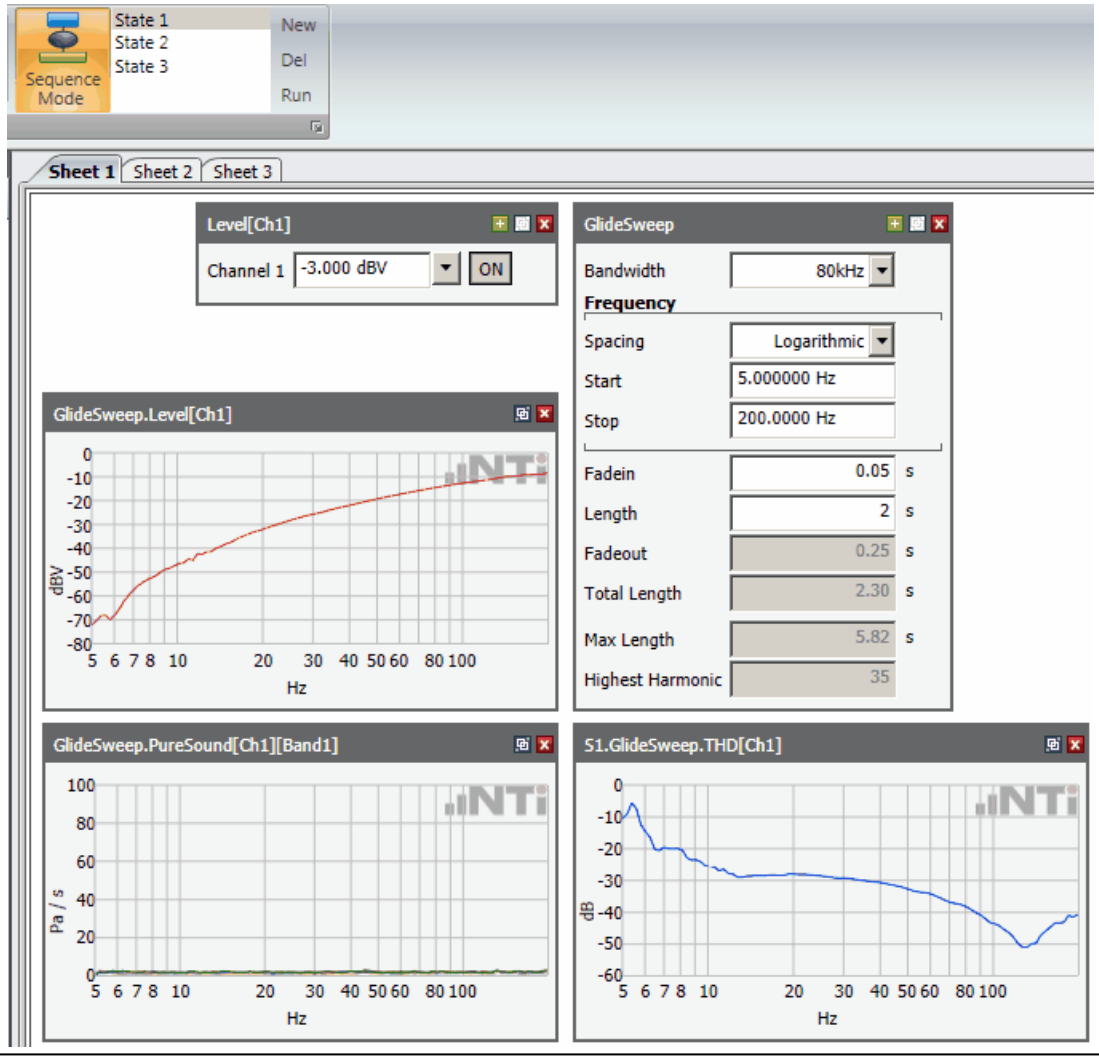
States

State 1 - Woofer



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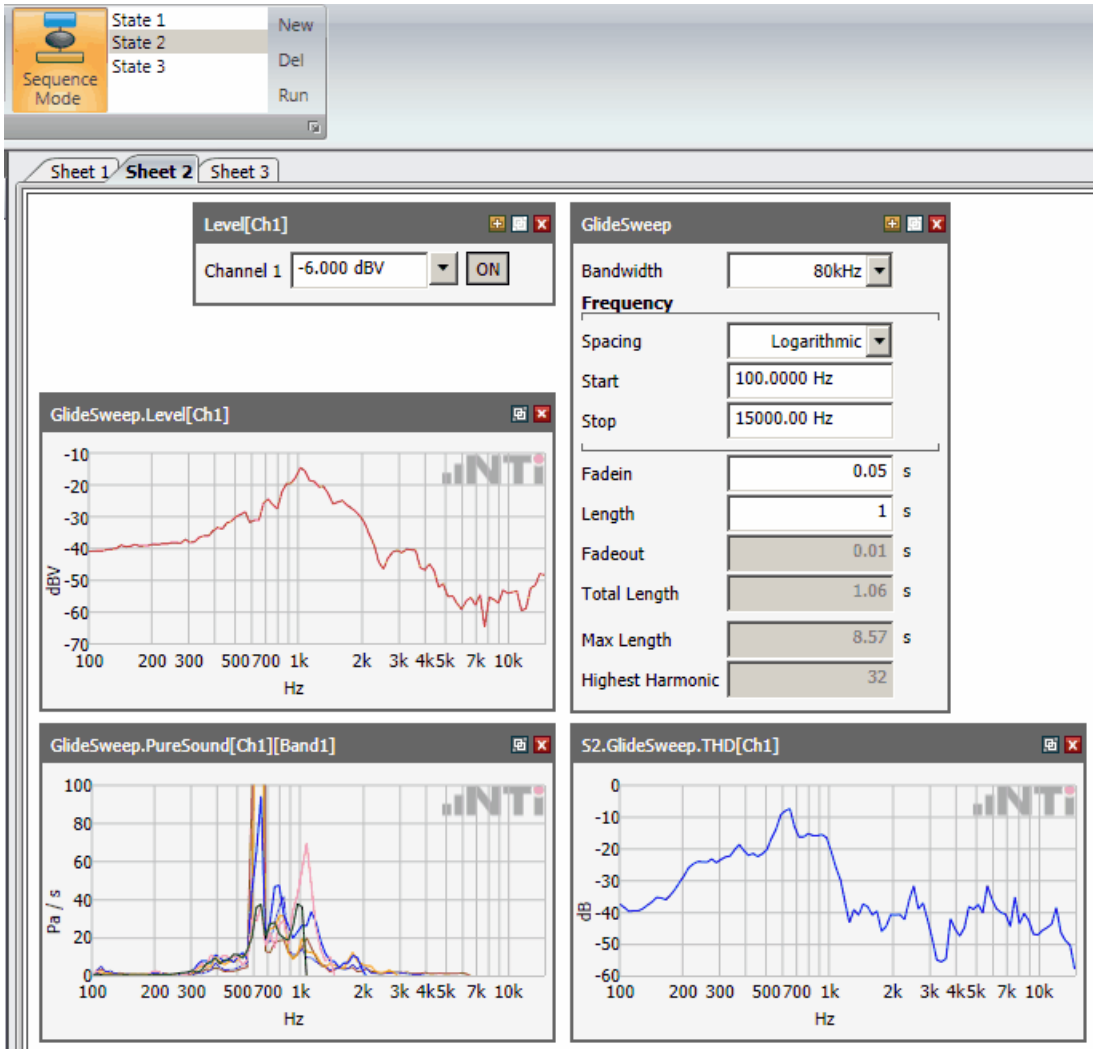
State 2 - Midrange driver



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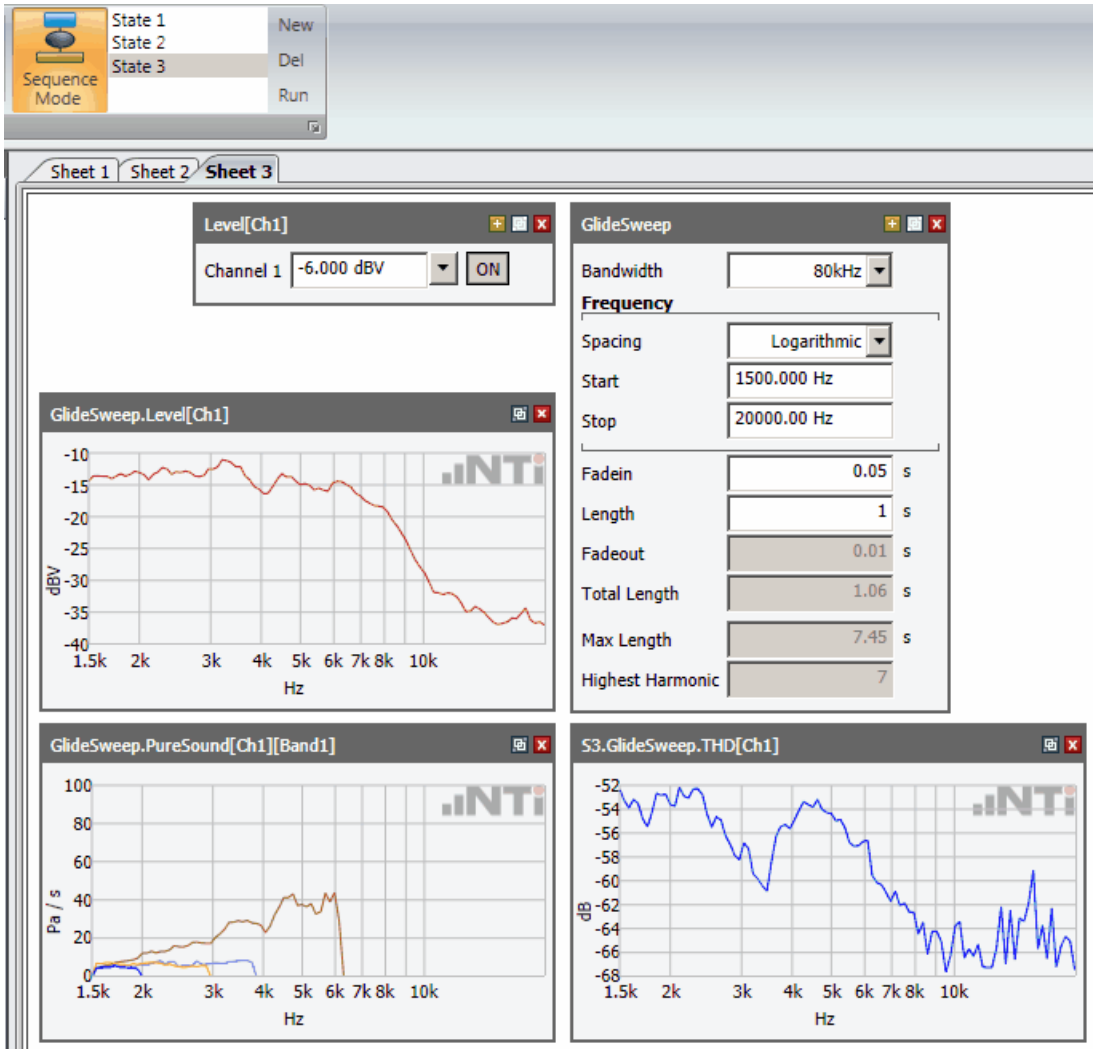
State 3 - Tweeter



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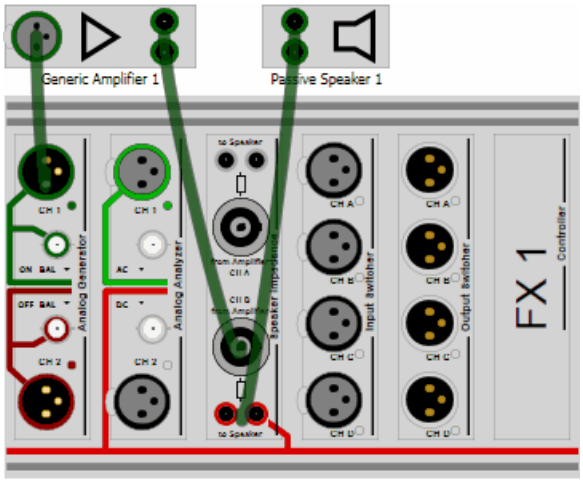
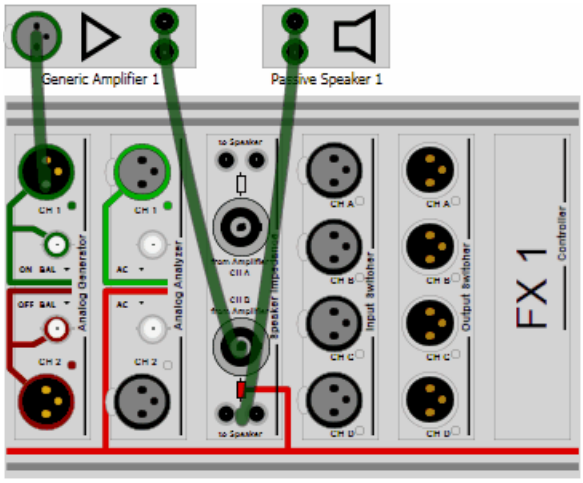
10.3.4 d) DCR, impedance response

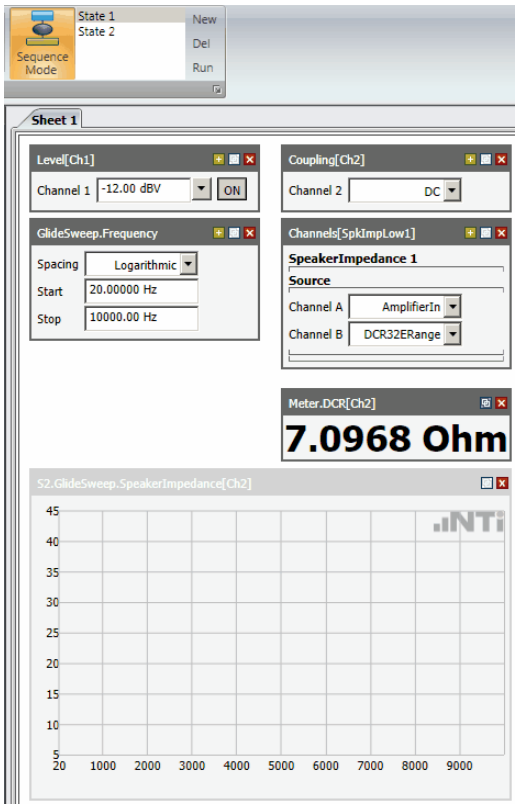
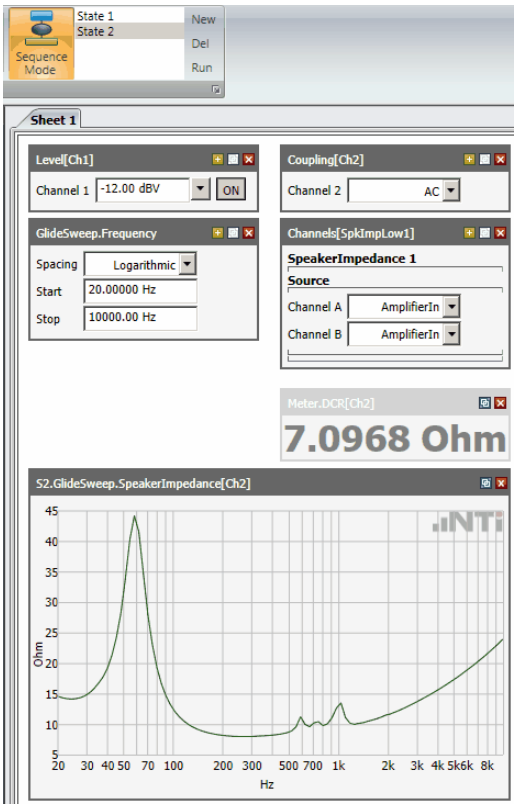
Measure the DC resistance and the AC impedance response of a DUT (Device Under Test) ⇒ The sequence comprises two steps, whereby the FX100 analyzer coupling is switched to

1. DC for the DCR measurement
2. AC for the impedance response

Wiring

State 1: DCR measurement: DUT linked directly to DC-coupled analyzer	*State 2: AC impedance: shunt resistor linked to AC-coupled analyzer*
	

States

State 1	*State 2*
	

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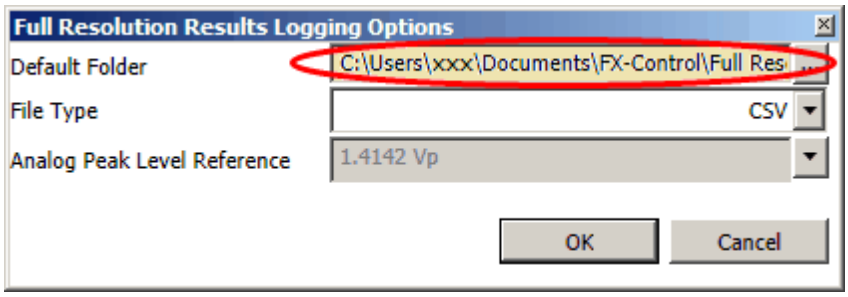
10.3.5 e) Octave band measurement

Calculate the octave or 1/3rd octave spectrum, based on an FFT measurement (similar to a RTA = real-time analyzer).

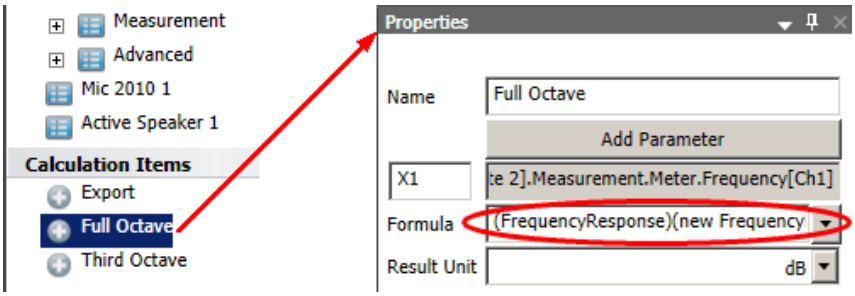
Preparations

1. Copy the folder "`FFT2RTA`" to your PC; the package is available
   - on the FLEXUS product-CD
   - under http://my.nti-audio.com
2. Double-click on "`setup.exe`" and install the software.
3. Open the FX-Control project "`RTA measurement`".
4. In the 'Logging' ribbon, click on the button

(Full resolution data) and copy the path to the default folder to the clipboard (*Hint: the path below is just an example*).



5. In the worksheets toolbox, click on the calculation item "Full Octave" and paste the path in the properties to the related formula:



The complete formula string shall read e.g.: "`(FrequencyResponse)(new FrequencyResponse.Converter()).ConvertFrom(null, null, System.IO.File.ReadAllText(@"C:\Users\xxx\documents\FX-Control\Full Resolution Results\RTAFullOct.txt"))`"

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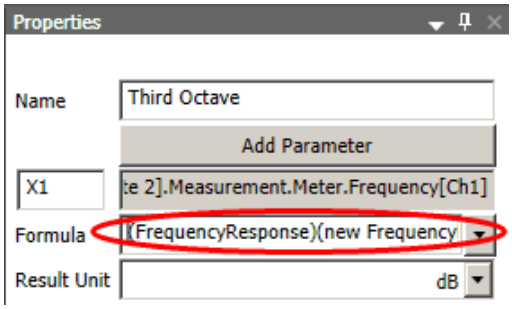
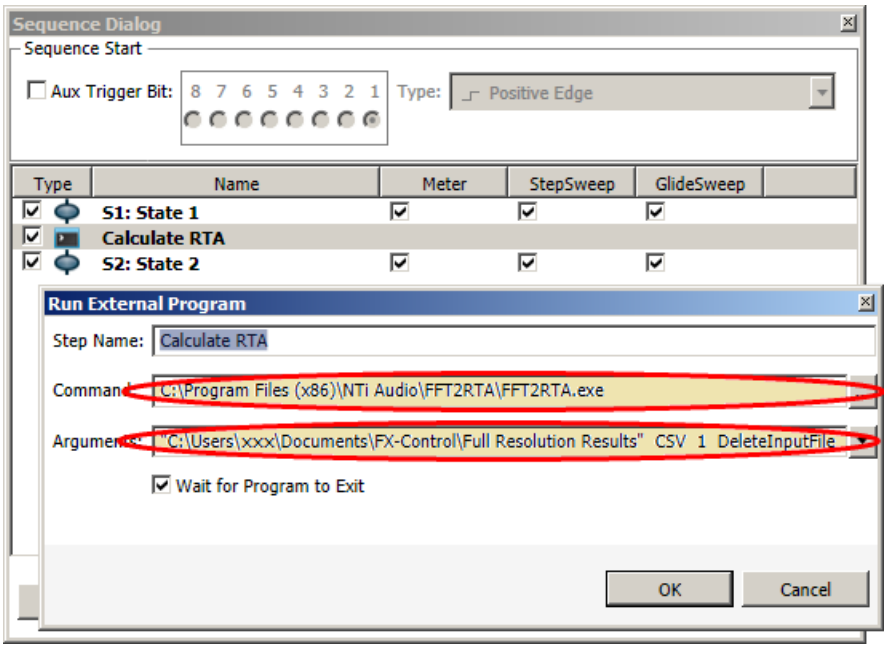
6. Paste the path to the formula of calculation item "Third Octave":



Updated 'Formula' string: "`(FrequencyResponse)(new FrequencyResponse.Converter()).ConvertFrom(null, null, System.IO.File.ReadAllText(@"C:\Users\xxx\Documents\FX-Control\Full Resolution Results\RTAThirdOct.txt"))`"

7. Open the Sequence Dialog panel via the 'Start' ribbon, double-click on the "Calculate RTA" step and update the paths under 'Command' and 'Arguments'.



Updated 'Arguments' string: "`"C:\Users\xxx\Documents\FX-Control\Full Resolution Results" CSV 1 DeleteInputFile`"

i. "`"C:\Users\xxx\Documents\FX-Control\Full Resolution Results"`" must be written in quotation marks and identifies the directory, where the full-resolution FFT file will be logged.

ii. "`CSV`" defines the log file format (CSV or TXT).

iii. "`1`" defines the analyzer channel, to which the measuring microphone is connected.

iv. "`DeleteInputFile`" is an optional parameter; if it is entered, the FFT log file will be deleted as soon as it has been processed by the software.

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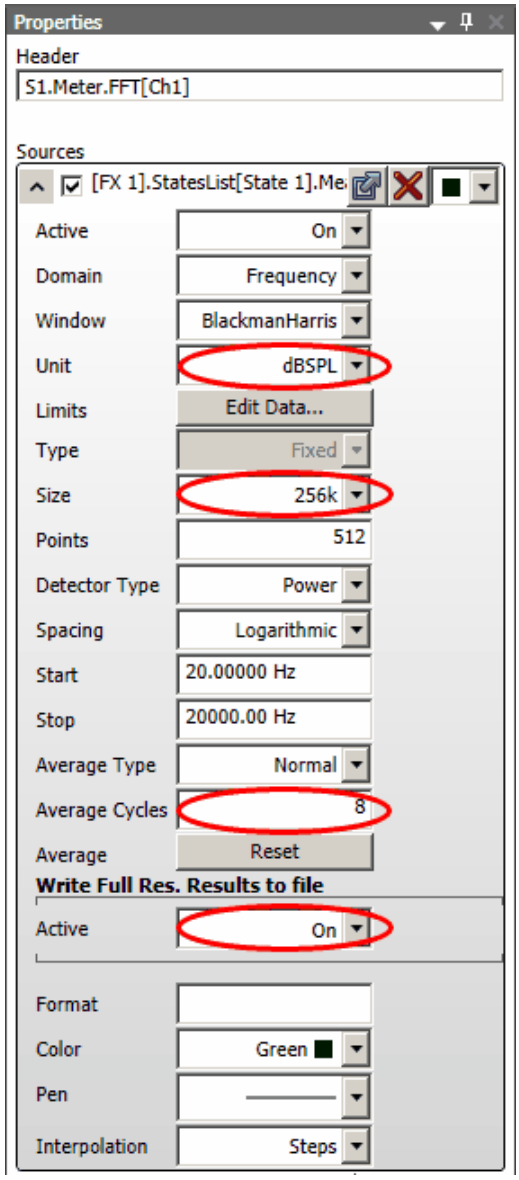
8. Select State #1 and edit the properties of the FFT measurement graph:

   - Select a logarithmic 'Unit', as e.g. 'dBSPL', 'dBV' or 'dBu'.
   - The 'Size' must be minimum 256k
   - If you want to prolong the acquisition length, you may either increase the 'Size' or the number of 'Average Cycles'.
   - Make sure that the 'Active' selector is switched to 'On'.



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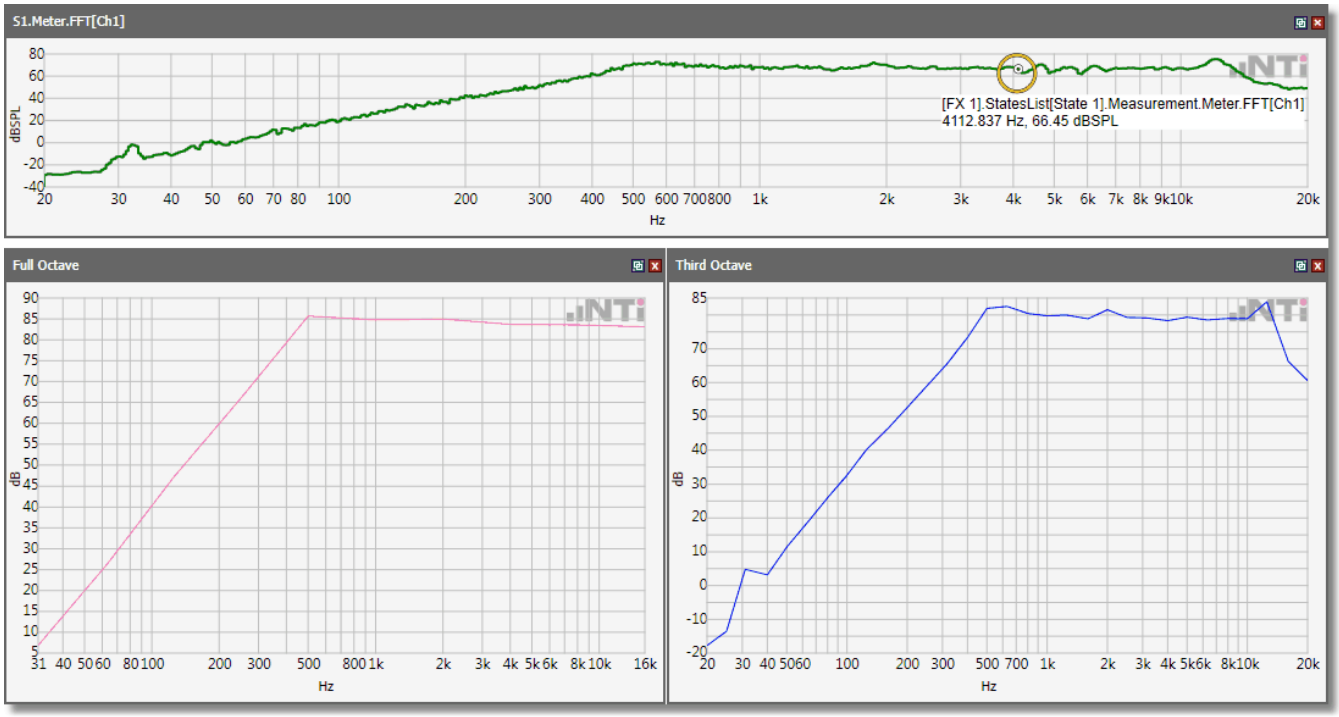
9. Execute the sequence to acquire & display the results (*Hint: the whole procedure takes several seconds*).



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Part

11 Advanced

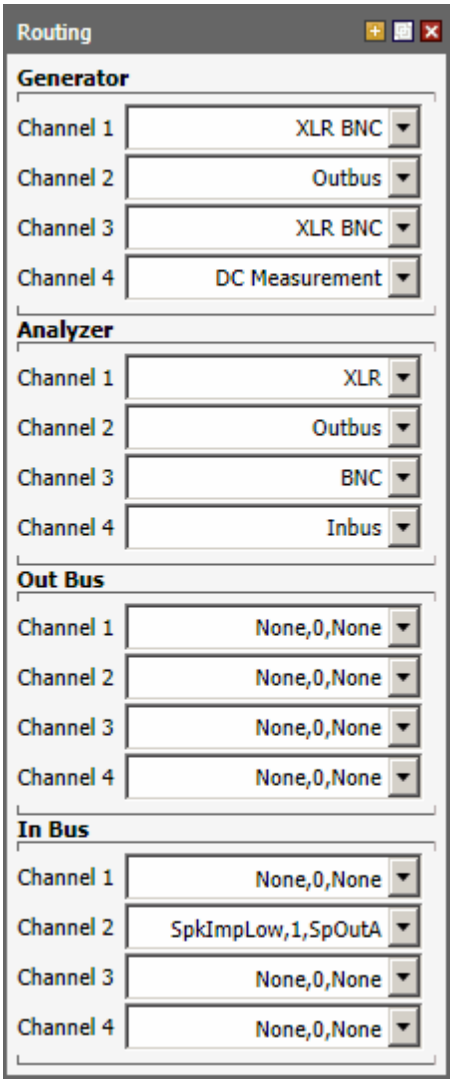
The advanced section provides access to the

- Internal routing of the FX100
- Properties of the installed options
- Language of FX-Control menu entries
- Distortion calculation method
- Ambient temperature
- Headphone connector status

11.1 Routing

The routing defines the internal links of FX100.

Hint ***Please refer also to chapters System operation, Wiring ribbon and Hardware & Wiring.***



- Generator output channels to
  - XLR + BNC connector
  - Outbus
  - DC Measurement (*refer to DCV, DCR*)
- Analyzer input channels to
  - XLR connector
  - BNC connector
  - Inbus
  - Outbus
- Out Bus to
  - none
  - an installed plug-in board (*e.g. FX-OS output switcher*)
- In Bus to
  - none
  - an installed plug-in board (*e.g. FX-SIL, FX-SIH or FX-IS*)

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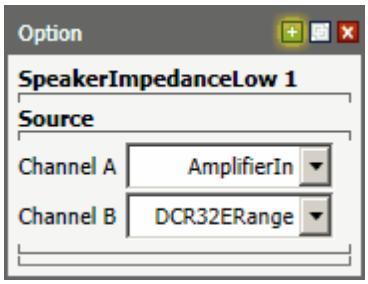
11.2 Option

The section provides access to the properties of the installed options

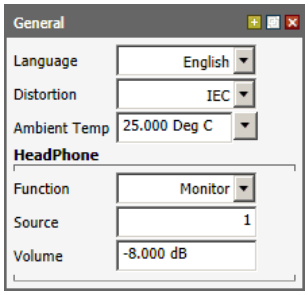
- OutSwitcher
- InSwitcher
- SpeakerImpedanceLow
- SpeakerImpedanceHigh

Example: FX-SIL



- AmplifierIn → Speakon™ IN connected to amplifier output
- Protected → Speakon™ IN disconnected from internal circuit, e.g. due to an overflow
- DCR32ERange → internal current source of the SIL is active (it is possible to measure the DC impedance of the connected DUT (Device Under Test) in the range from 1.5 to 1500 Ω)

11.3 General



- Language → select the language of the FX-Control menu entries.
  - English
- Distortion → select the calculation method for the Total Harmonic Distortion (THD) measurement (*see below*)
  - IEC
  - IEEE
- Ambient Temp → enter the ambient temperature, expressed in degree Celsius [C] or Fahrenheit [F] (required for the time window calculation)

HeadPhone → provides access to the operation of the headphone jack

- Function
  - Monitor → the signal *behind* the input filter stage (e.g. A-weighted or Lowpass filtered etc.)
  - PureSound → the input signal *behind* the PureSound bandpass-filters
- Source → input channel number (1, 2, 3, or 4)
- Volume → output signal volume, -80...39.5 dB

IEC

$$THD_{IEC} = \frac{TotalDistortionEnergy}{SignalEnergy + TotalDistortionEnergy} = \frac{\sqrt{V_2^2 + V_3^2 + \cdots + V_n^2}}{\sqrt{V_1^2 + V_2^2 + V_3^2 + \cdots + V_n^2}}$$

IEEE

$$THD_{IEEE} = \frac{TotalDistortionEnergy}{FundamentalEnergy} = \frac{\sqrt{V_2^2 + V_3^2 + \cdots + V_n^2}}{V_1}$$

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Part XII

12 Application hints

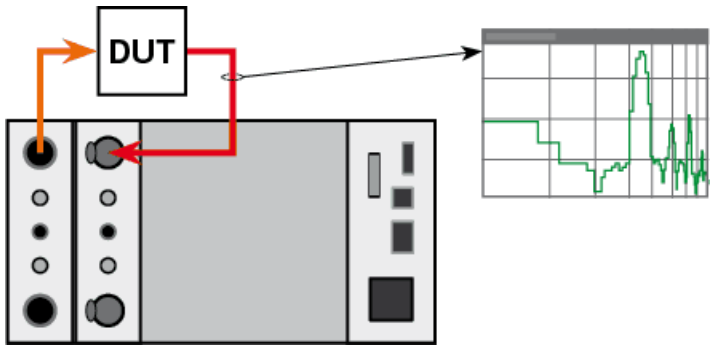
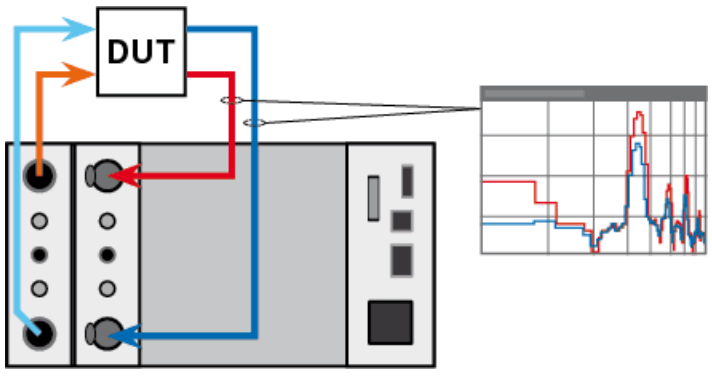
- Demo projects
- Tutorial
- X/Y-axis scaling
- Analysis of external signals
- Measurement speed
- Template for build report
- Shortcuts, mouse operation
- IEEE 488

12.1 Demo projects

The FX-Control installation CD includes a number of demo projects for typical applications.

Basic projects

Meter projects

Demo project (file name)	*Description, hints*	*Application examples*
1-Chn FFT	A simple 20 Hz to 20 kHz audio bandwidth FFT measurement via analyzer channel 1. Use the properties section of the result graph to parametrize the FFT analysis, e.g. The test signal is transmitted acoustically or via an electrical connection. Alternatively, it is also possible to analyze an externally generated signal.	
2-Chn FFT	A simple 20 Hz to 20 kHz audio bandwidth FFT measurement via analyzer channel 1 & 2. Use the properties section of the result graph to parametrize the FFT analysis, e.g. The test signal is transmitted acoustically or via an electrical connection. Alternatively, it is also possible to analyze an externally generated	

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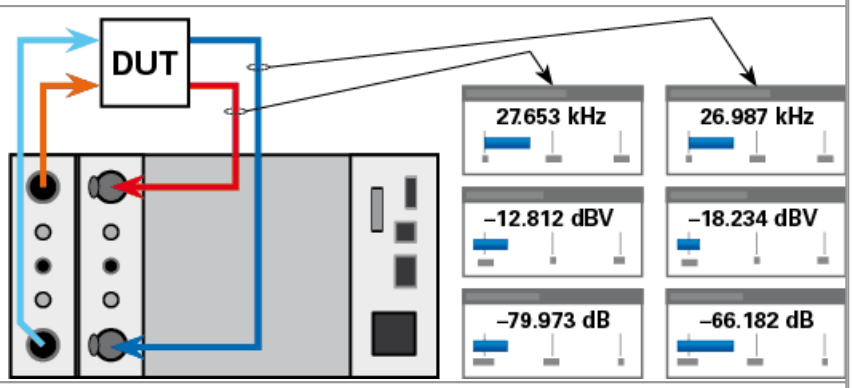
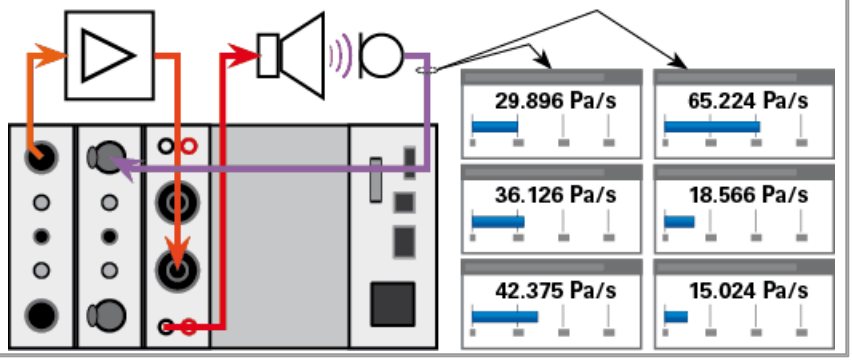
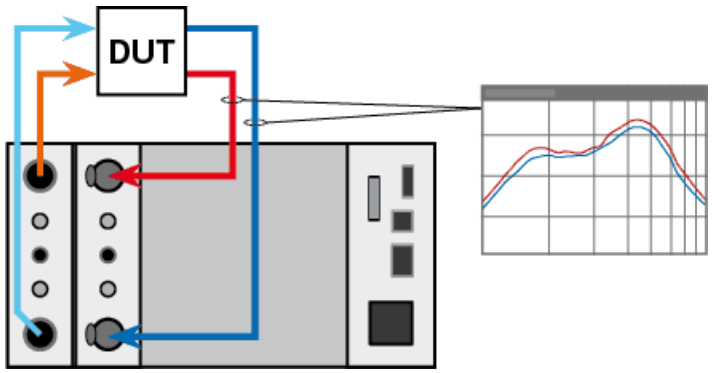
	signal.	
2-chn standard Audio bargraph monitor	A simple 20 Hz to 20 kHz Audio bandwidth FFT via analyzer channels 1 & 2. Use the properties section of the result graph to parametrize the FFT analysis.	
PureSound monitor	Measures & displays all six PureSound bands in parallel as bargraphs. NOTE - This project requires a valid PureSound license on your FX100.	

GlideSweep projetcs

Demo project (file name)	***Description, hints***	***Application example***
2-chn frequency response *2-chn Level / THD / Phase*	Executes a 1 sec. GlideSweep and acquires the active measurements on channels 1 & 2	

Calculations projects

Demo project (file name)	***Description, hints***	***Application examples***

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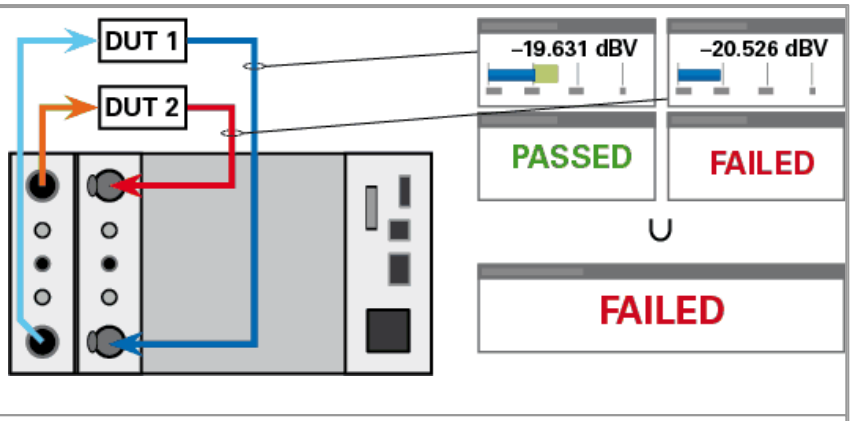
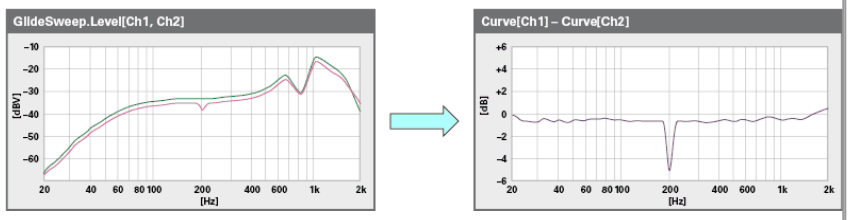
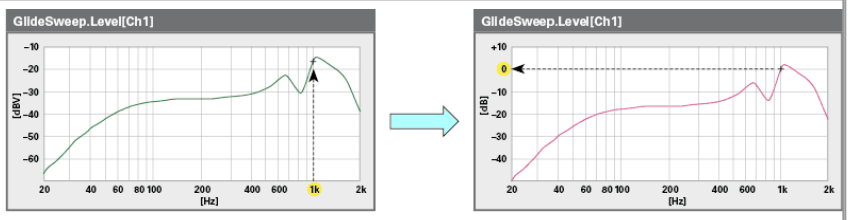
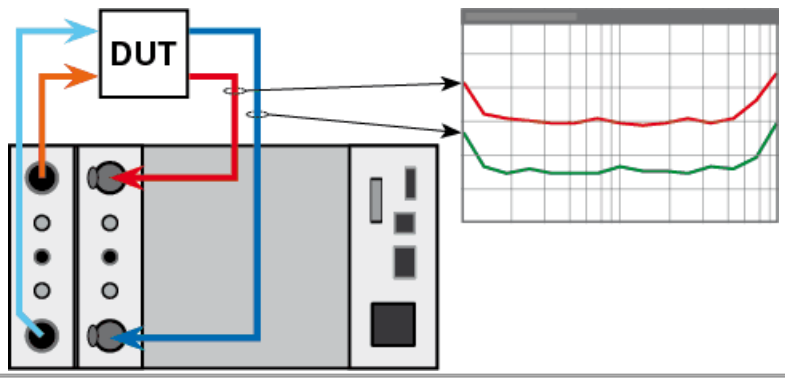
Boolean calculation	1. Measures the Meter level of Ch1, Ch2 and checks the results against individual limits 2. Verifies, whether both measurements are within the limits and shows the overall result in a separate PASSED/FAILED display	
Curve subtraction	1. Measures the GlideSweep frequency reponse of Ch1, Ch2 2. Calculates & displays the difference of the two recorded curves	
Relative to frequency	1. The instrument executes a 1-channel GlideSweep level measurement. 2. In a second graph, the recorded curve is displayed relatively to its level at 1 kHz (i.e. level @ 1 kHz = 0 dB) The "Linear Interpolation" calculation item determines the level value at 1 kHz -> this value is then subtracted from the original curve.	
Regulators		

StepSweep projetcs

Demo project (file name)	***Description, hints***	***Application examples***
Level (frequency response)	Executes a StepSweep from 20 Hz to 2 kHz with 60 pts, while measuring the Level on channels 1&2.	

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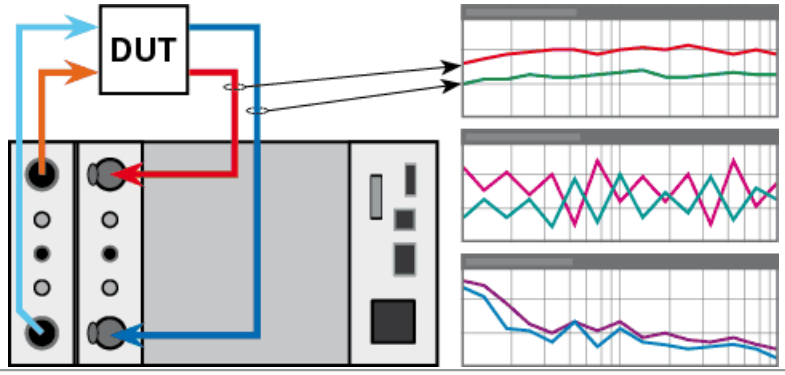
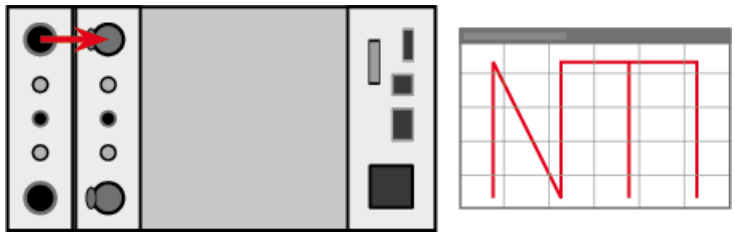
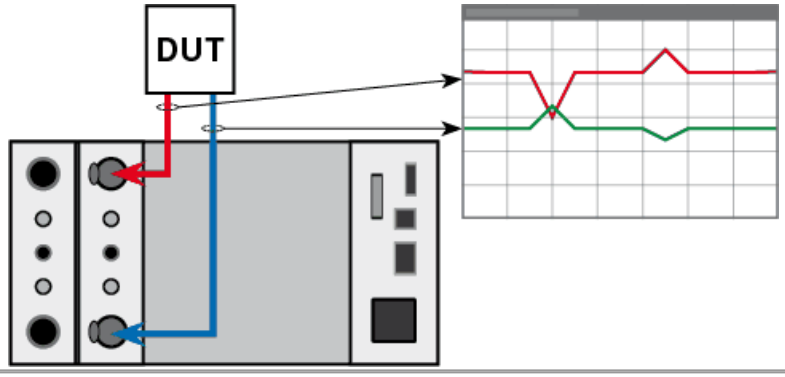
Level_Phase_THD	Executes a StepSweep from 20 Hz to 20 kHz with 60 pts, while measuring Level, THD and Phase on channels 1&2.	
Table_Sweep_NTI	The FX100 executes a table sweep on channel 1, i.e. generates a series of frequency/ amplitude pairs. NOTE - The generator and analyzer of chn1 are linked internally, i.e. the test signal is NOT transmitted through an external DUT.	
Time_Sweep	Performs a 10 seconds Time Sweep, while measuring the input Level on channel 1&2. NOTE - Make sure that the input range is adjusted properly prior to starting the measurement.	

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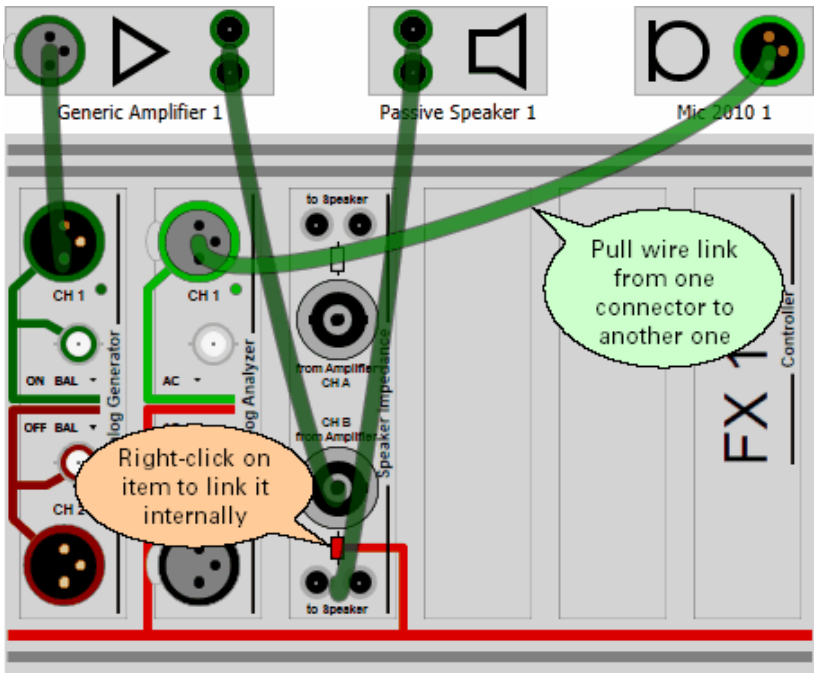
12.2 Tutorial

The following paragraphs describe ways of setting up basic measurements. i.e.

1. Establish the correct wiring
2. Adjust the generator settings (i.e. test signal parameters)
3. Adjust the analyzer parameters (e.g. bias, input ranging, settling etc.)
4. Activate the required measurements and result panels
5. Define the tolerance limits (optional)
6. Activate & customize the result data logging

1. Wiring

Single transducer test setup



Recommended wiring for single transducer test with SIL option

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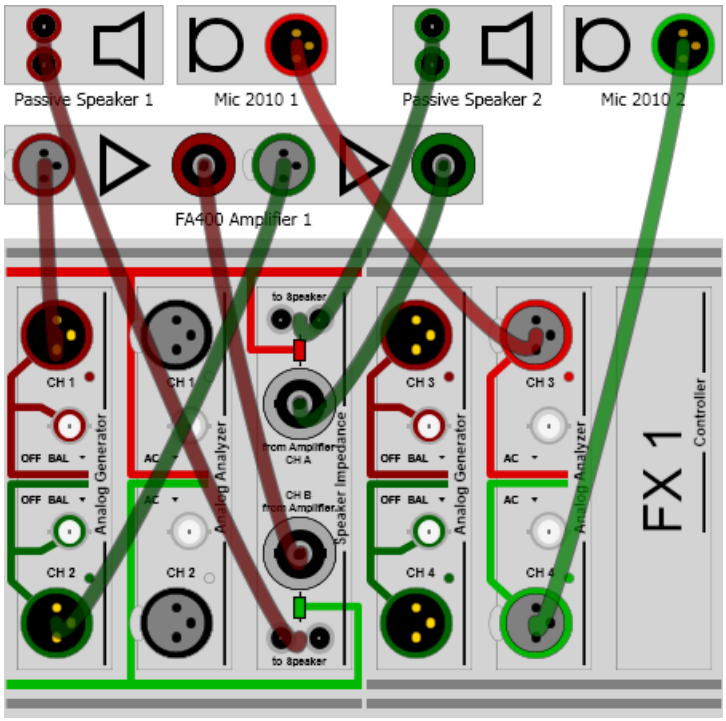
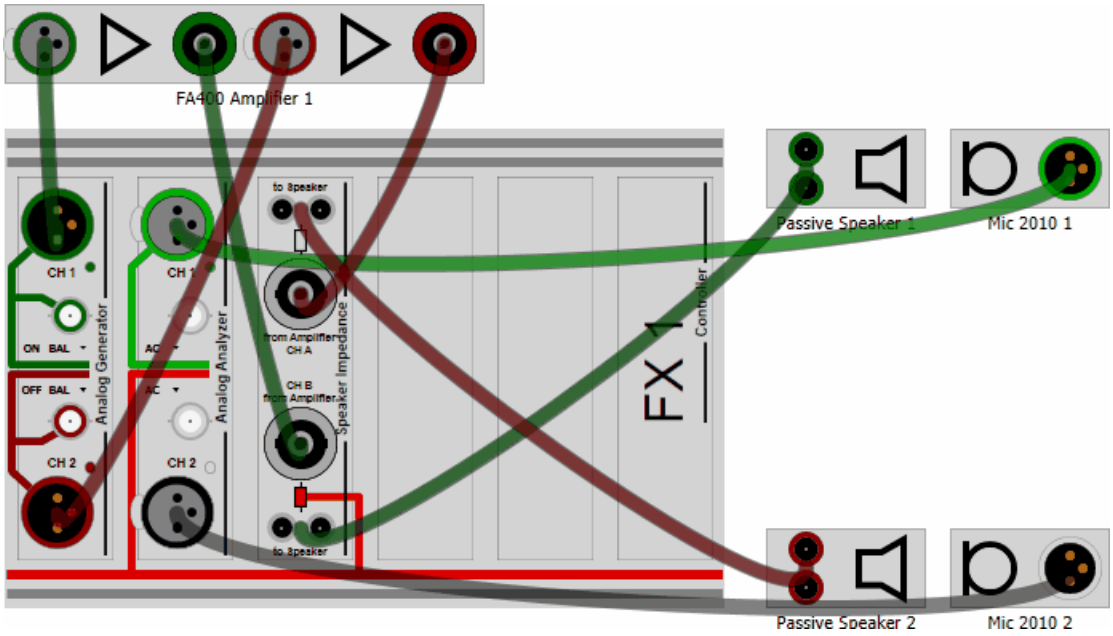
Dual transducer test setup (parallel analysis)



Recommended wiring for parallel testing of two transducers with SIL option

Dual transducer test setup (sequential analysis)



Recommended wiring for sequential (alternating) testing of two transducers with SIL option

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2. Test signal parameters, measurements

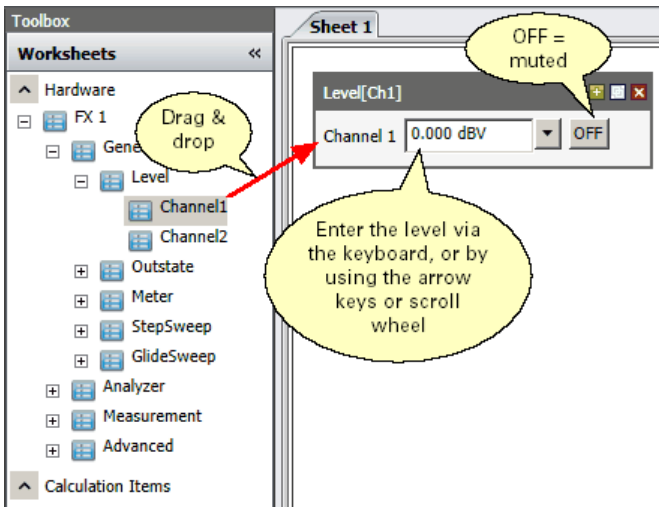
FX-Control supports two different approaches to select & adjust the generator settings, test parameters and measurement functions,

1. via the Toolbox: drag&drop the required panels from the tree to the worksheet
2. via the Ribbon: click on a button of the Worksheets ribbon to open the corresponding measurement panel or item

Via the toolbox

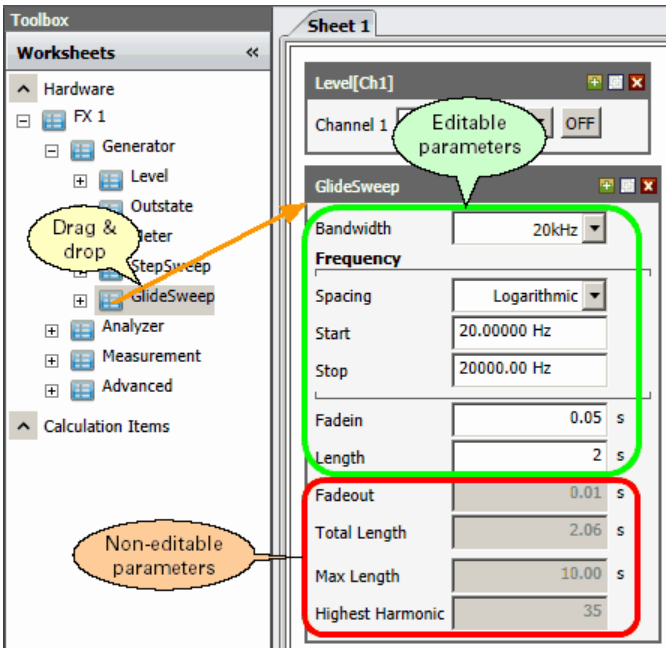
Example 1 — Adjust the generator chn.1 level

- In the Worksheets toolbox, expand the tree to "FX 1 → Generator → Level".
- Drag&drop the 'Channel 1' panel to the worksheet.
- Click on the button to select the level measurement unit
- Enter the required output level manually or by using the scroll wheel.
- Toggle the generator output button from 'OFF' (i.e. muted) to 'ON' to activate the output signal.

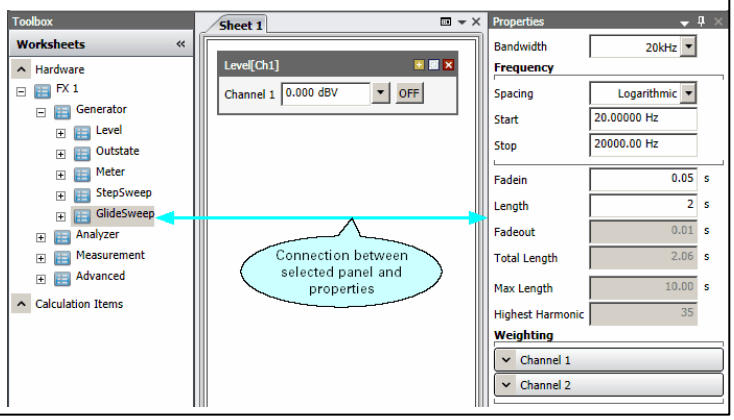


Example 2 — Adjust the GlideSweep test parameters

- Open the tree to "FX1 → Generator → GlideSweep"
- To edit the GlideSweep parameters, you can either
  - drag & drop the 'GlideSweep' panel to the worksheet



  - or access the parameters in the 'Properties' section



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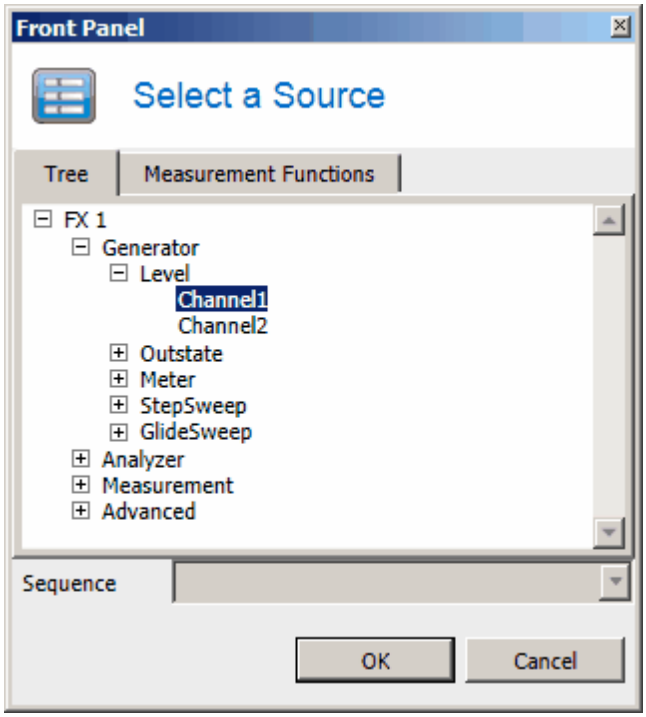
Via the ribbon

- Click on the 'Front Panel' button in the Worksheets ribbon
- Under the 'Tree' tab, click on FX 1 → Generator → Level → Channel2
- Confirm by pressing the 'OK' button



3. Analyzer parameters

The analyzer parameters are adjusted the same way as the generator status (*see above*), e.g.

- AC or DC coupling
- Microphone settings (e.g. power supply, sensitivity)
- Filter
- Input range

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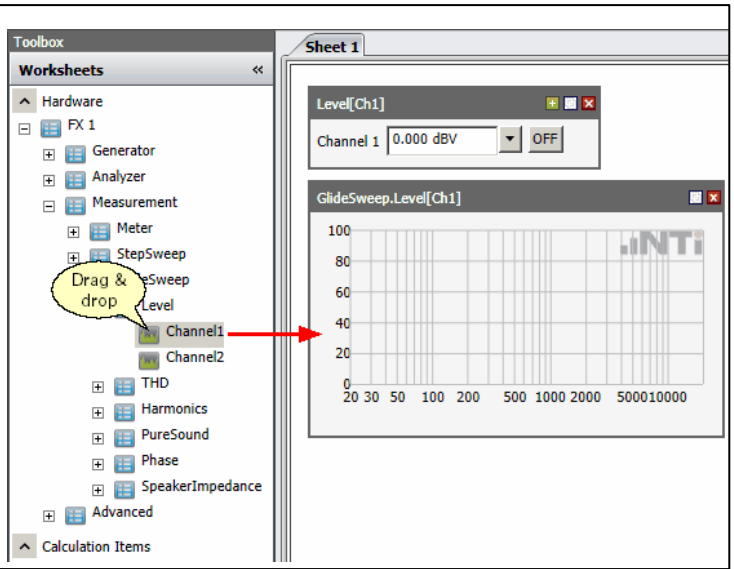
4. Measurements

Activate the required measurements by placing the related result display on the worksheet

Example: GlideSweep level

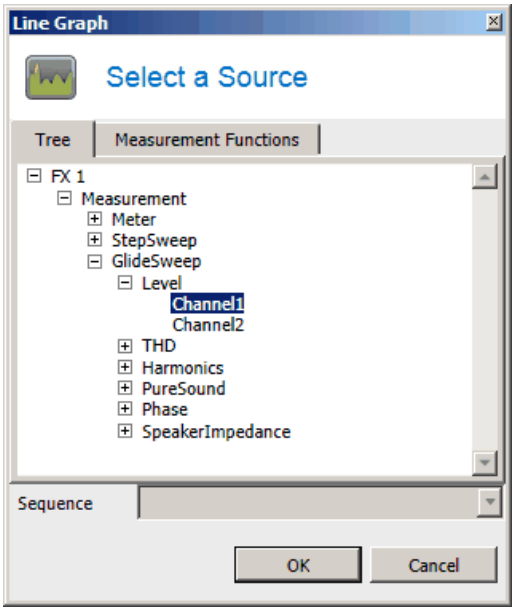
Example 1 — Drag & drop from the tree

- Look for the entry "FX1 → Generator → Measurement → GlideSweep → Level → Channel1"
- Drag & drop the panel to worksheet to activate the related measurement



Example 2 — Via the Worksheet ribbon

- Click on the 'Line Graph' button in the Worksheets ribbon
- Activate the measurement function either
  a) under the 'Tree' tab; click on Measurement → GlideSweep → Level → Channel1 and press the 'OK' button, or



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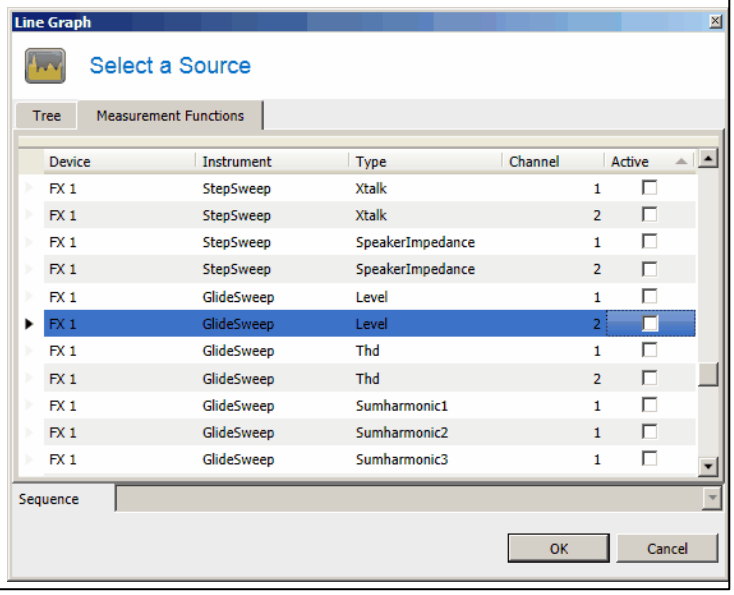
a) under the 'Measurement Functions' tab; select the line "**Device: FX1 → Instrument: StepSweep → Type: Level → Channel: 2**" and confirm by clicking on the 'OK' button.



5. Tolerance limits

Every measurement result can be checked individually against customized acceptance limits, which are defined either

- manually, or
- in a semi-automated procedure.

(*please refer to the corresponding chapters*)

6. Data logging

- Activate the automated logging of the acquired result data e.g. by pressing on the button in the quick access toolbar.
- Customize the logging settings via the button 'Settings' in the Logging ribbon.

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12.3 X/Y-axis scaling

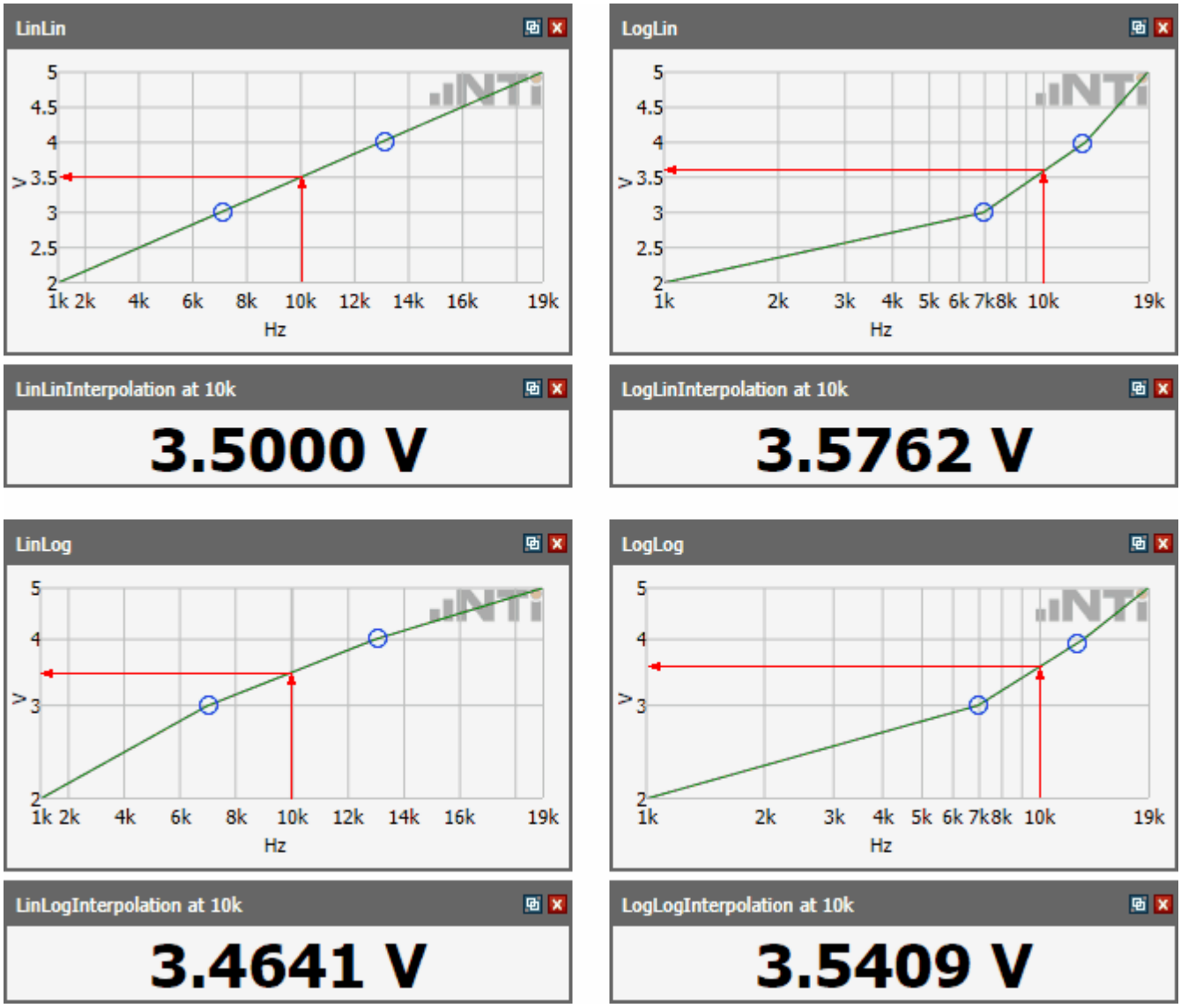
The scaling of a result graph, i.e. linear or logarithmic X-/Y-axis may have a major impact on

a) linear interpolation
b) tolerance limits

It is therefore essential to make sure that the X-/Y-axis scaling are adjusted properly prior to the application of these features.

Example

The following picture shows four result graphs of a 4-point sweep measurement, whereby each graph has a different scaling.



The numerical values below the graphs represent the linear interpolation of the level @ 10 kHz of the corresponding graph. The differences between the numerical results come from the fact that

- the displayed result curves (green lines) are drawn by directly connecting neighbored points (blue circles)
- the interpolated result (red arrows) is acquired 'graphically'

Hint ***Each of the shown curves or numerical results is 'correct' – but only in conjunction with the corresponding scaling.***

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12.4 External signal analysis

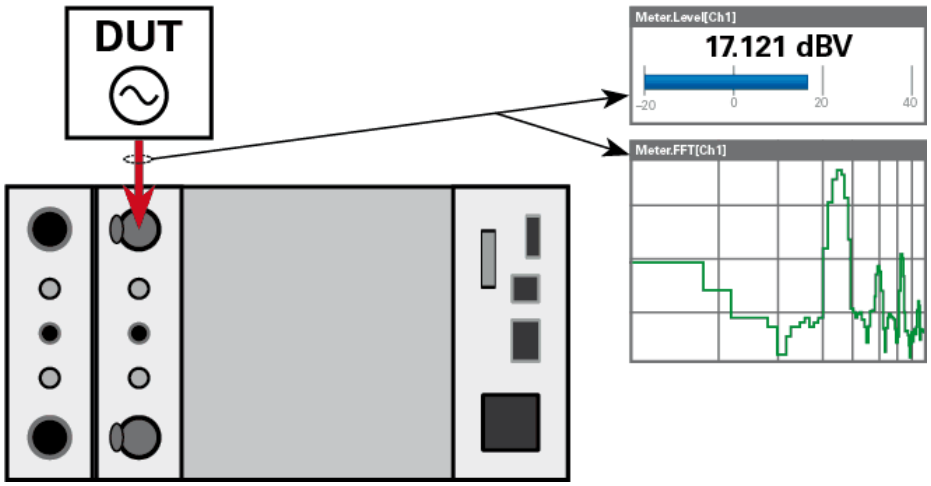
FX100 can be used to analyze test signals that have been generated by an external device (e.g. MP3 player, PC, eBook reader etc.)

A) External Meter measurement

i. Select external Meter synchronization → the FX100 analyzer automatically acquires the incoming signal in wideband mode.

ii. Activate the required measurement(s).

iii. Acquire the measurement(s) in a single shot or continuously.



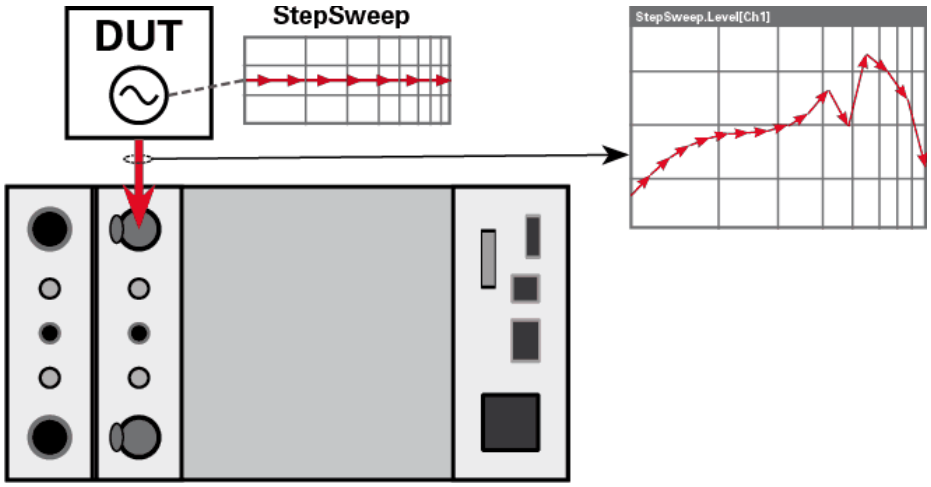
B) External StepSweep analysis

i. Switch the analyzer StepSweep synchronization to external.

ii. Align the start, stop frequencies of the FX100 analyzer to the bandwidth of the externally generated StepSweep.

iii. Define the StepSweep timeout → if no stable input signal comes in after initiating the measurement, FX100 will abort the acquisition after expiration of the timeout period.

iv. Run the measurement continuously or start it at a specific time.



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C) External GlideSweep analysis

The FX100 Device is able to sample & analyze an externally generated GlideSweep. This feature is especially helpful for applications where the test signal can not be routed from the FX100 generator through the DUT (e.g. MP3 players, notebooks etc.). The transmitted GlideSweep must comprise a specific header that allows the FX100 analyzer to trigger correctly to the incoming signal, and can be easily created under FX-Control and saved on the DUT.

i. Adjust the generator signal parameters of the GlideSweep (i.e. bandwidth, spacing, start/stop frequency, fade-in and length).

ii. Create a sound file of the GlideSweep in wav or mp3 format and save it on the external device.

iii. Adjust the analyzer GlideSweep settings, i.e.

- select the sense channel that shall trigger to the incoming GlideSweep signal
- adjust the number of points.
- define the GlideSweep timeout → if no FX100 proprietary GlideSweep preamble signal is received after initiating the measurement, FX100 automatically aborts the acquisition after expiration of the timeout period

NOTE **It is essential that the GlideSweep generator parameters of the analyzing FX100 are identical to those of the externally replayed GlideSweep signal.**

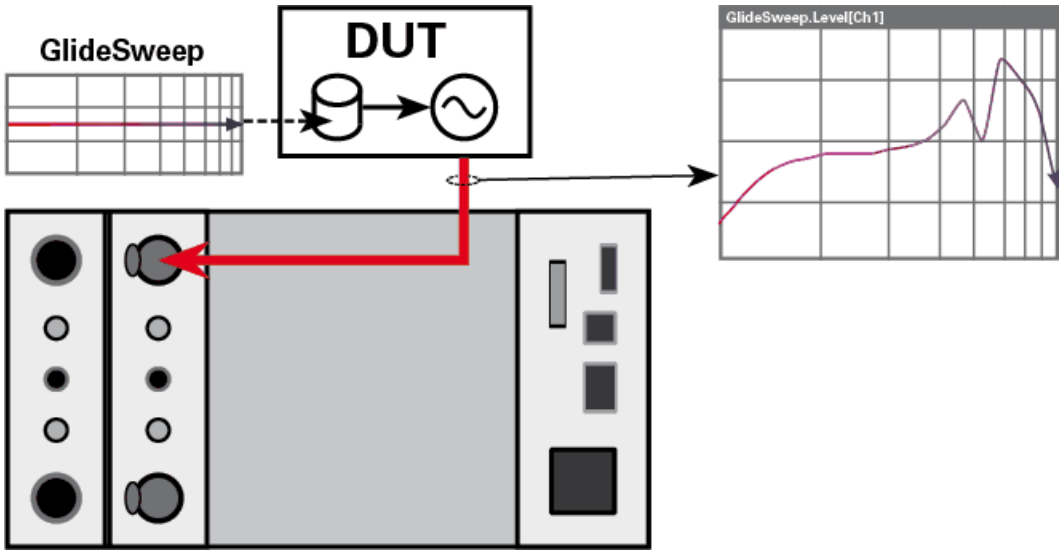
iv. Activate the required measurement(s), e.g.

- Level
- Distortion
- PureSound steepness
- Signal latency

v. Initiate the measurement(s) and replay the GlideSweep signal from the external device (NOTE – In case of a signal latency measurement, the measurement start and the signal replay must start at the same time).

Hint ***It is recommended to mute the FX100 generator during the measurement.***

vi. The FX100 analyzer consequently monitors the active input channel until it triggers to the fixed header of the GlideSweep signal ⇒ the analyzer synchronizes to the incoming signal and starts the measurement.



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Sample rate adjustment

If a GlideSweep signal shall be analyzed that has been generated by an external device, the FX100 analyzer sample rate must be synchronized to the incoming test signal. For this purpose, every exported GlideSweep starts with a header that allows the FX100 analyzer to trigger correctly to the incoming signal and to measure the sample rate of the replay device.

However, there are two issues that have to be considered carefully in this mode.

a) The sample rate of an external device that is generating a GlideSweep may differ from the internal FX100 sample rate (192 kHz). The FX100 therefore automatically recognizes and compensates such sample rate deviations. If the difference however exceeds the maximum allowance of ±5 %, significant errors in the GlideSweep frequency or distortion response measurement may occur.

b) If an acoustically coupled external GlideSweep analysis is executed in the presence of loud ambient noise, the measurement of the header's sample rate may be compromised. This can negatively affect the result of the signal latency measurement. Consequently, the analyzer sample rate adjustment shall be turned Off in a very noisy environment.

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12.5 Measurement speed

The following list provides general hints on speeding up your measurement(s). However, keep in mind that every setup must be considered individually to achieve optimum results.

General hints

- Use GlideSweep rather than StepSweep measurements
- Avoid to repeatedly altering the input bias
- Avoid the logging format XLSx

StepSweep

- Switch Analyzer synchronization to Generator
- Minimize the number of points
- Adjust the start frequency > stop frequency
- Switch the settling OFF

GlideSweep

- Minimize the GlideSweep length (i.e. duration)

12.6 Template for build report

The chapter describes the procedure to establish a template for build reports under MS Word. If you prefer another desktop publisher program, please proceed accordingly.

Hint ***Please contact NTi Audio if your need further assistance to establish a Build report.***

Step 1

i. Under MS Word, open a new document and name it; this will become your template file.

ii. Format the document according to your demands, e.g. by adding the
   - logo of your company in the header,
   - permanent text or graphs that will not change (see picture under Step 6).

Step 2

i. Run FX-Control, set up your test and activate the required measurements.

ii. Establish a sequence with minimum one state.

iii. Add a build report,

iv. Select the Template File (e.g. the word document from Step 1)

v. Enter a name for the Output File.
   - No name (i.e. input box is left blank) ⇒ every time the sequence is executed, a new Output File is created with the default name "<Step name><Date><Time>"
   - Fixed name (e.g. "Result Sheet") ⇒ every time the sequence is executed, the one & only Output File gets overwritten (*Side note – requires the Post Build Action "Print"*)
   - Indexed name (e.g. "$[Input x]" or "%[FX1].SerialNumber") ⇒ every time the sequence is executed, an Output File is created with the indexed name (*Side note – if the indexed name does not change, the Output File gets overwritten*)

vi. Select the Post Build Action, i.e. either
   - (None) ⇒ Output File is created without any further action

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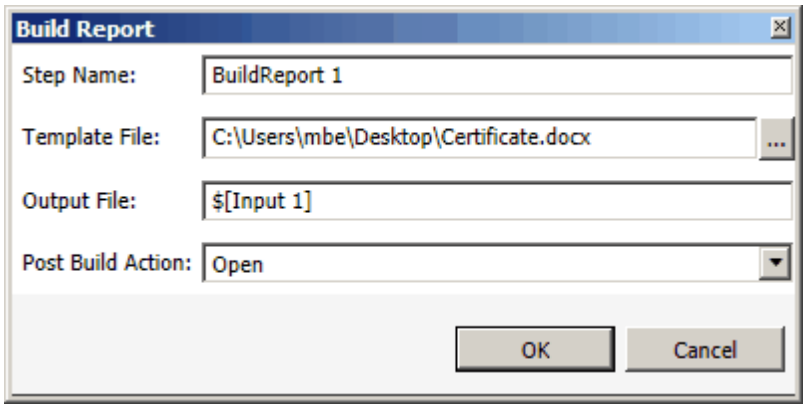
- Open ⇒ Output File is created & opened
- Print ⇒ Output File is created & printed



Step 3

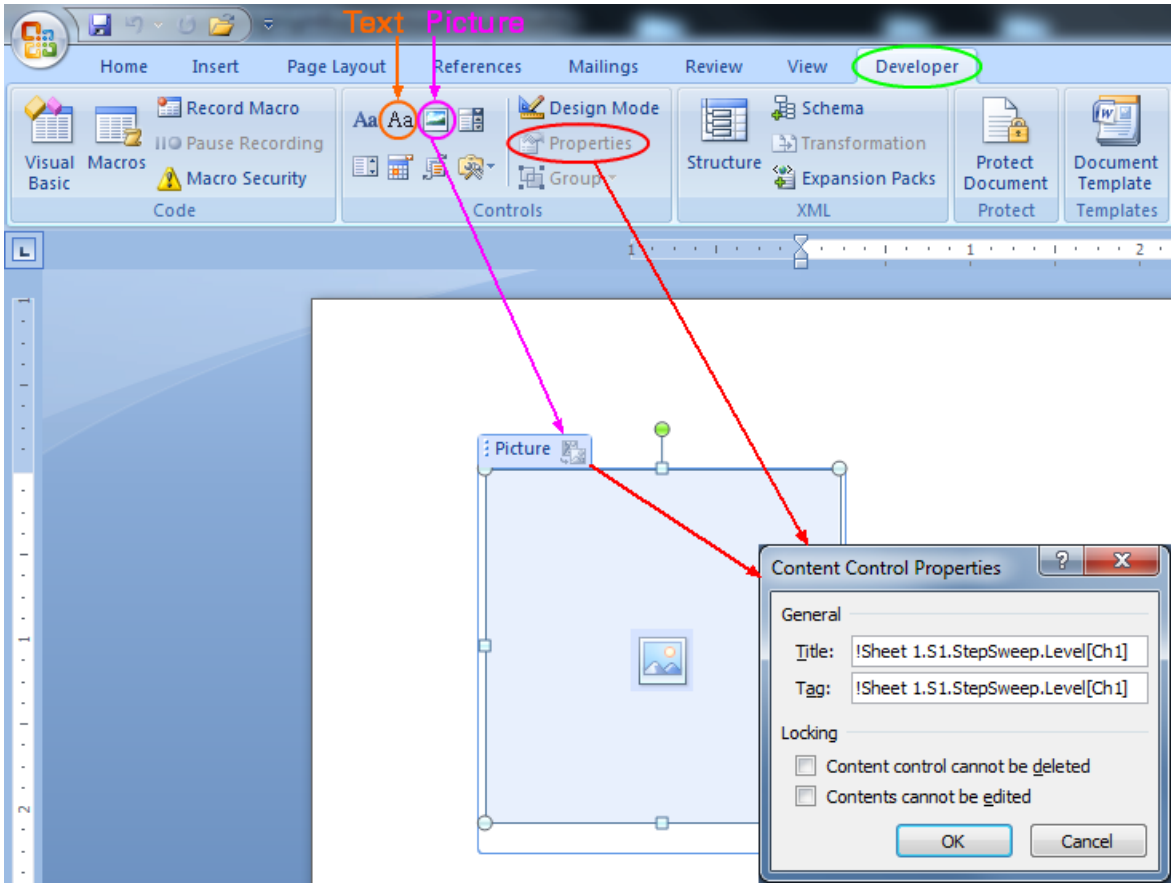
i. Swap to MS Word and open the Template document.

ii. Click on the "Developer" tab.

iii. Add the required container elements that shall display the exported build report contents.
- Click on the "**Aa**" button to add a text container
- Click on the button to add a picture container

iv. Click on a container element that has been placed to the document, and then on "Properties" in the Developer ribbon.

v. Edit the title & tag in the 'Content Control Properties'.



MS Word template with Picture container and properties

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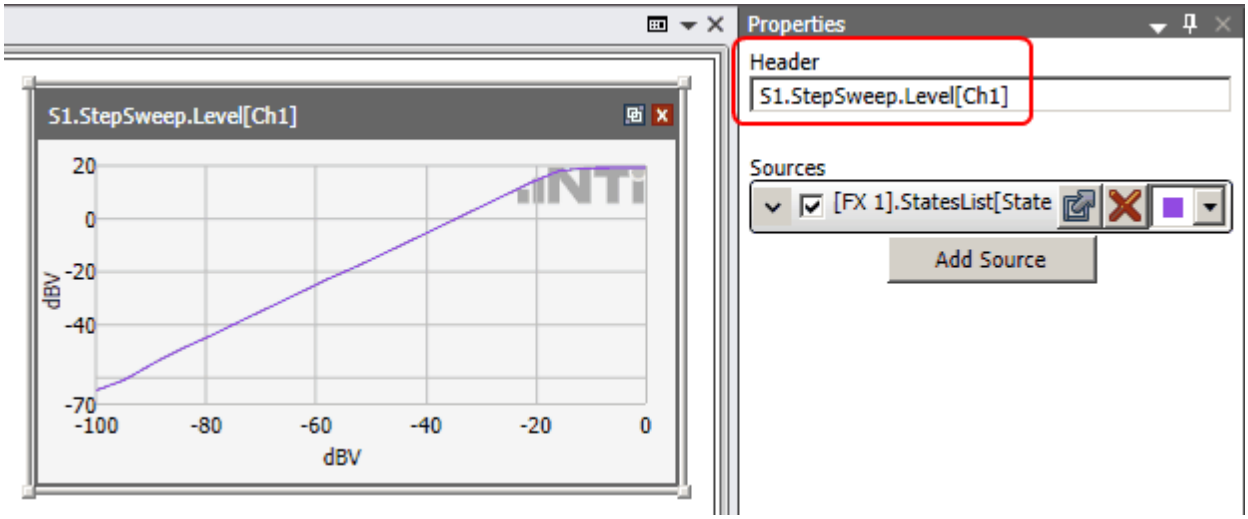
Step 4

i. Swap to FX-Control.

ii. Click on the measurement panel that shall be exported to the document.

iii. In the properties of this measurement panel, copy the Header string.



Header string of measurement panel

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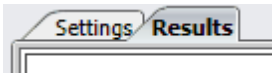
Step 5

i. Swap back to MS Word

ii. Write "`!Sheet.`" to the Title, Tag lines, whereby "`Sheet`" is the name of the FX-Control worksheet on which the result panel is located (e.g. "`!Results`").



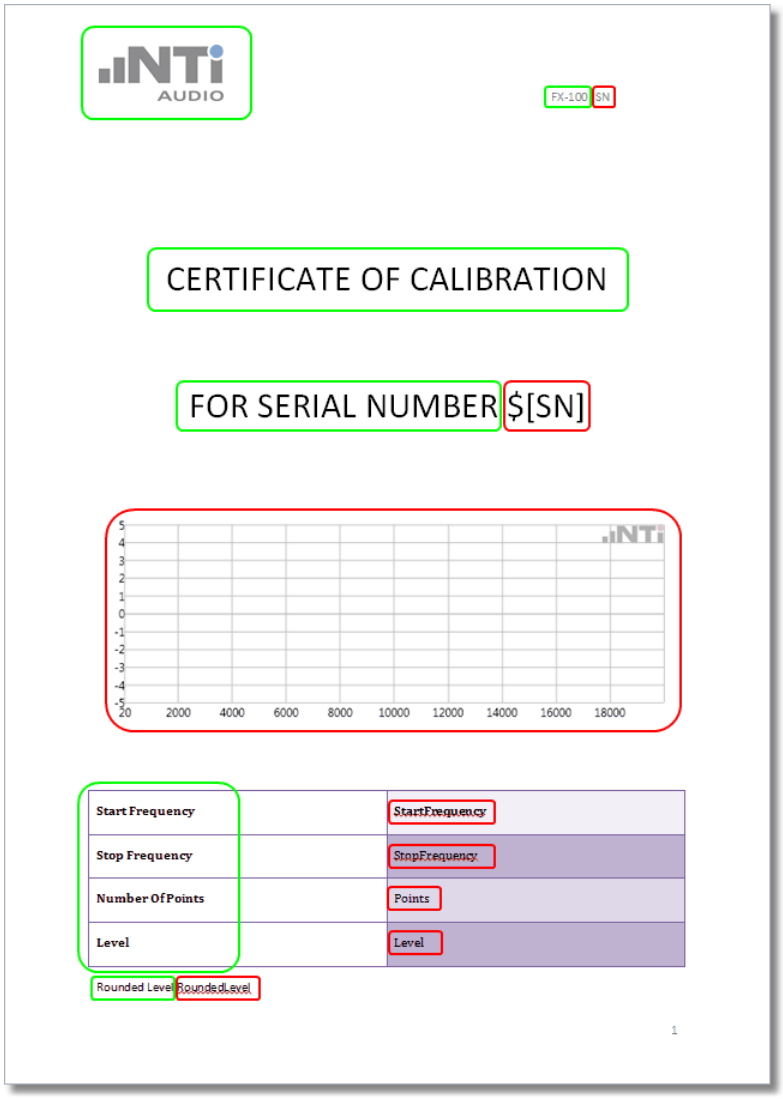
iii. Paste the copied Header string from the measurement panel properties (*Step 3*) directly behind Sheet name.

iv. Click on 'OK' to confirm.

Step 6

i. Repeat *Steps 3...5* for every text or graph container that shall be placed in your template file.

ii. Edit the containers according to your requirements, e.g.
- text container: exact location in the document, character font & size, paragraph attributes,
- graph container: exact location in the document, size.



Green: permanent graphs or text / Red: containers for exported data

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12.7 Shortcuts, mouse

Always

Alt	show shortcuts
Ctrl + 1	the actual input level at channel 1 becomes the new reference level
Ctrl + 2	the actual input level at channel 2 becomes the new reference level
Ctrl + C	copies the active item in the Hardware & Wiring or Worksheets view, respectively
Ctrl + N	clear all items in the Worksheet and the Hardware & Wiring view, and open a new project
Ctrl + O	open a specific project
Ctrl + P	print the contents of the current worksheet (see chapter 'View' ribbon)
Ctrl + S	save the current project settings
Ctrl +Shift + S	save the current settings under a new project name
Ctrl + V	pastes the copied item to the Hardware & Wiring or Worksheets view, respectively
F5	run single execution of active measurements of all connected FX100 instruments
F6	run repeated execution of active measurements of all connected FX100 instruments
F8	abort measurement
Right-click in WorkArea	opens a pop-up menu with the buttons of the 'Worksheets' ribbon

Specific panels

Panel	*Shortcut*	*Effect*
Harmonics properties	Shift	Select all harmonics between two selected ones (e.g. click on 5, then <Shift> + 10 ⇒ automatically activates harmonics 6, 7, 8, 9, too)
	Ctrl	Exclusively activates the selected harmonic, i.e. all other harmonics are deactivated
Tolerance graph editor	Shift	When moving a point within the graph, only its X-value can be amended, while the Y-value is kept
	Ctrl	When moving a point within the graph, only its Y-value can be amended, while the X-value is kept
	Alt	Snap to whole numbers both in X, Y-direction
StepSweep, GlideSweep amplitude profile editor	Shift	When moving a point within the graph, only its X-value can be amended, while the Y-value is kept
	Ctrl	When moving a point within the graph, only its Y-value can be amended, while the X-value is kept
	Alt	Snap to whole numbers both in X, Y-direction
Level value editor	F4	Opens drop-down menu with available measurement units
	left mouse button	Hold left mouse button while using the scroll wheel ⇒ the level values are amended in value steps of 10
Frequency value editor	left mouse button	Hold left mouse button while using the scroll wheel ⇒ the frequency values are amended stepwise (5, 10, 20, 100, 1k, 10k, 20k, 40k, 80k)
Graphical result display	left mouse button	• Hold the left mouse button and move it over the graph to zoom in to the corresponding area. • Double-click on the graph with the left mouse button to show the full display.

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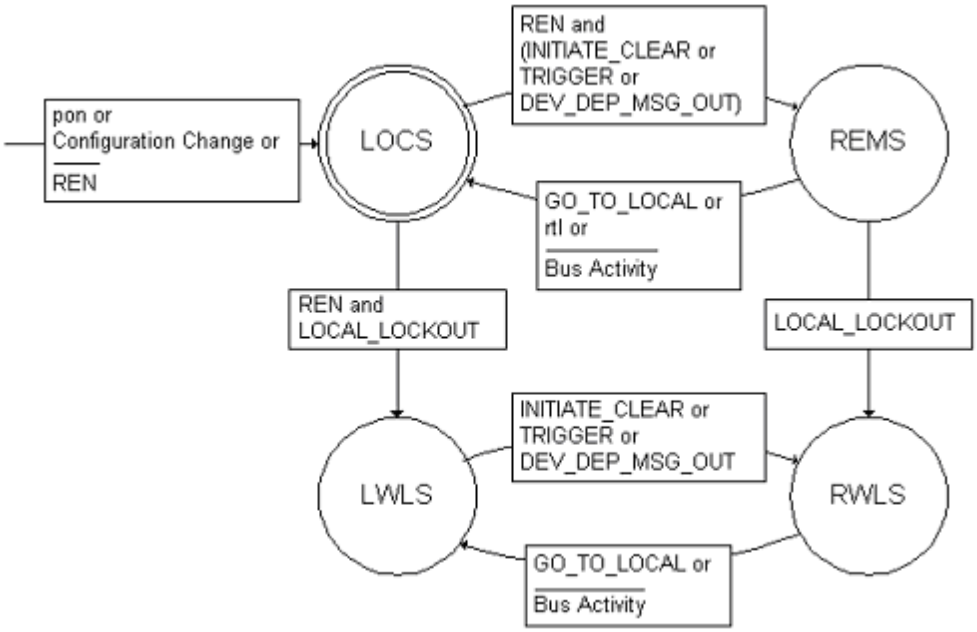
12.8 IEEE 488

The FX100 Device follows the RL state diagram for USB defined in the USB Subclass specification rev1.0 (p.14, fig.2) and in the IEEE 488.1-1987 standard (p.37, fig.10).



LOCS (Local State)

The LOC State ...

- is the initial state after startup, wherein the user can change between any pages and execute any operations.
- will not change, until the PC Software sends a Remote-Enable request.
- is also entered when the PC Software de-asserts the Remote-Enable request.

If the Remote-Enable was asserted, the LOC state changes to the Remote State on ...

- any SCPI message
- trigger message
- Initiate Clear request.

If a Local-Lockout request is received from the PC Software, the LOC state is changed to the Local-with-Lockout-State, but only if the Remote-Enable was asserted.

REMS (Remote State)

The FX100 will stay in REM state ...

- as long as it is not disconnected from the PC
- until the PC Software sends a Go-To-Local request
- until the PC Software sends a user input.

The FX100 interprets any user input in this state as a Return-To-Local local message. There is no special Return-To-Local button.

If a Local-Lockout request is received from the PC Software, the state is changed to the Remote-with-Lockout-State.

Note that the Remote-Enable is asserted when the FX100 is in the Remote State.

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LWLS (Local With Lockout State)

In the Local-with-Lockout-State the user can change between any pages and can do any operations.

The state changes to the Remote-with-Lockout-State on ...

- any SCPI message
- a trigger message
- an Initiate Clear request.

RWLS (Remote With Lockout State)

If this state is entered, the FX100 Device returns immediately to the test page from any other position in any other page.

In the RWL state any user input is locked except headphone settings (source, channel, volume), and the user cannot change to any local state. This gives the PC software the full control over the FX100 Device.

For any user inputs, the PC Software must send a Go-To-Local request. Then the FX100 Device changes to the LWL state.

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Part XIII

13 Support

If you have specific questions or need professional support, please contact your local NTi Audio agent or any of the following service centers.

Americas

NTI Americas Inc.
PO Box 231027
97281 Tigard, Oregon
USA

Phon +1 (503) 684-7050
Fax +1 (503) 684-7051

t.mintner@nti-audio.com

www.ntiam.com

China

NTi China Co., Ltd.
Room 701, Ganglong Lisheng Mansion
No 60, Suli Road
Wuzhong District, 215168 Suzhou
PR China

Phon +86 (512) 6802-0075
Fax +86 (512) 6802-0097

china@nti-audio.com

www.nti-audio.com/cn

Germany

Schalltechnik Süd&Nord GmbH
Am Schwarzen 13
45239 Essen
Deutschland

Phon +49 (201) 5456-980
Fax +49 (201) 5456-981

besselmann@akustiktest.de

www.akustiktest.de

Japan

NTI Japan Ltd.
Ryogokusakamoto Bldg.
1-8-4 Ryogoku
Sumida-ku, Tokyo 130-0026
Japan

Phon +81 (3) 3634-6110
Fax +81 (3) 3634-6160

okayasu@nti-japan.com

www.nti-japan.com

Korea

NTi Audio Korea
Room 307, Taekwang Bldg. 57-3
Mullaedong 3-ga, Yeongdeungpo-gu
Seoul 150-835
South Korea

Phon +82 (2) 6404-4978
Fax +82 (2) 6407-4978

k.kim@nti-audio.com

www.nti-audio.com

Liechtenstein (Headquarter)

NTi Audio AG
Im alten Riet 102
9494 Schaan
Liechtenstein, Europe

Phon +423 239-6060
Fax +423 239-6089

info@nti-audio.com

www.nti-audio.com

UK

NTi Audio UK
PO Box 510
SG1 9LG Stevenage, Hertfordshire
United Kingdom

Phon +44 (1438) 870632
Fax +44 (1438) 749160

charles.greene@nti-audio.com

www.nti-audio.com

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Notes

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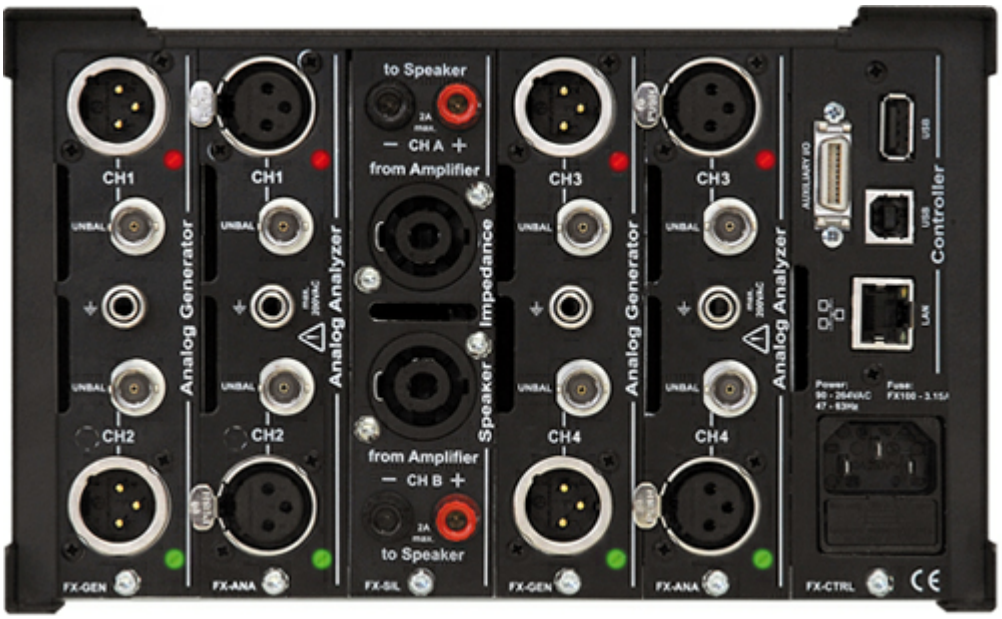
CH1
UNBAL
CH2
Analog Generator
FX-GEN
CH1
UNBAL
CH2
Analog Analyzer
FX-ANA
to Speaker
2A max.
— CH A +
from Amplifier
Speaker Impedance
from Amplifier
— CH B +
2A max.
to Speaker
FX-SIL
CH3
UNBAL
CH4
Analog Generator
FX-GEN
CH3
UNBAL
CH4
Analog Analyzer
FX-ANA
AUXILIARY I/O
USB
USB
LAN
Controller
Power:
90 - 264VAC
47 - 63Hz
Fuse:
FX100 - 3.15A
FX-CTRL
CE